AUDITORY COMPREHENSION AND VERBAL ENCODING IN AUTISM: Insights from Neuroscience for Language Intervention with AAC

Diane L. Williams, PhD, CCC-SLP, BCS-CL
Professor & Head of Dept of CSD, Penn State

Iowa Conference on Communicative Disorders

April 2024

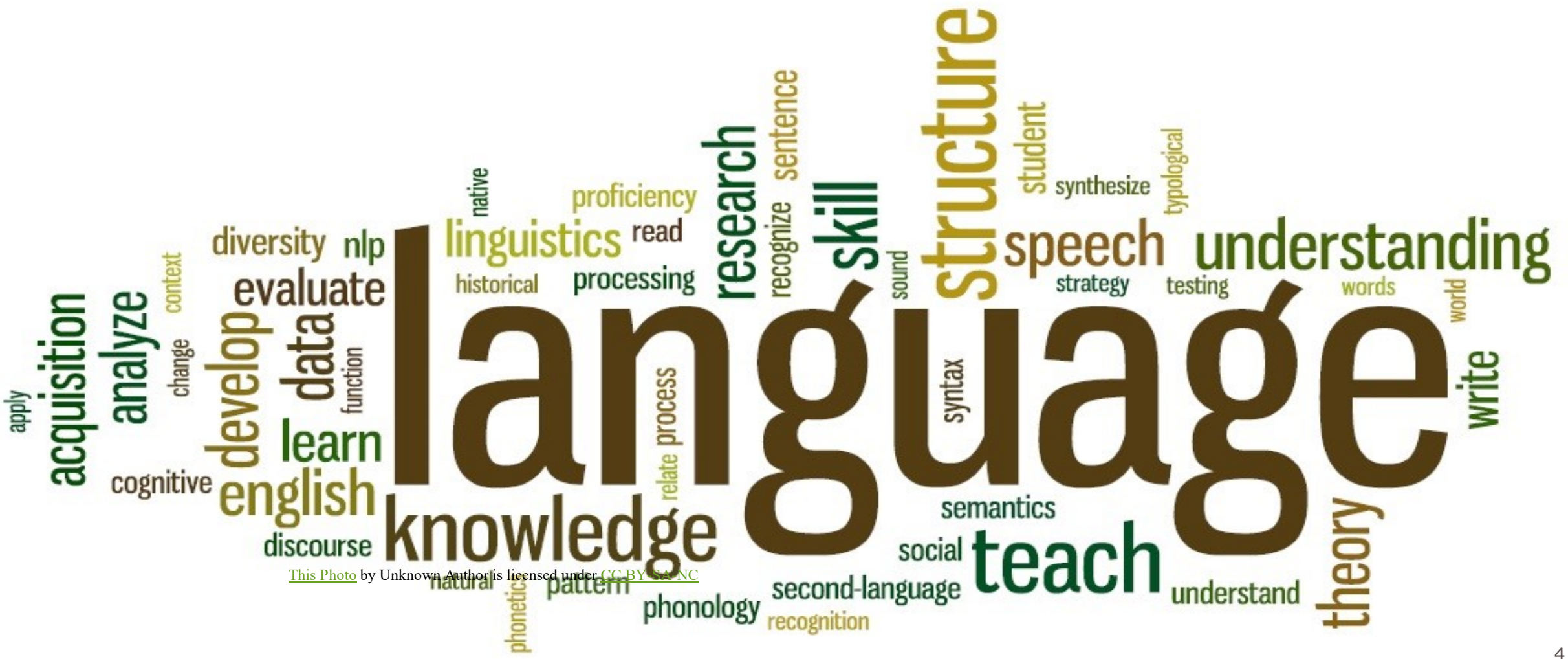
DISCLOSURES

- **Non-Financial Disclosure:**
  - Dr. Williams has no nonfinancial relationship to disclose
- **Financial Disclosures:**
  - Dr. Williams' travel expenses were covered for this presentation
  - She is an employee of Penn State University

LEARNER OUTCOMES

- Discuss recent findings from behavioral and neurofunctional research related to auditory comprehension and verbal encoding in individuals with autism
- Describe the impact of these neurobiologically-based differences on language learning in autism
- Apply these research findings to the design of language intervention incorporating AAC for toddlers, preschoolers, and school-age children with autism

A WORD ABOUT LANGUAGE



SORE THROAT ANALOGY

DISCLAIMER

- The intervention ideas I'll discuss
  - Are all drawn from Evidence-Based Practice
  - May not all be new to you
  - Hope is that connecting these with what we are learning about autism from neurofunctional research gives you a new perspective on implementation

AUTISM SPECTRUM DISORDER DSM-5 CRITERIA (APA, 2013)

- Persistent deficits in social communication and social interaction across contexts, not accounted for by general developmental delays
- Restricted, repetitive patterns of behavior, interests, or activities

OTHER DESCRIPTORS

- Type of onset
- Intellectual disability
- *Level of spoken language*
- Co-morbid conditions

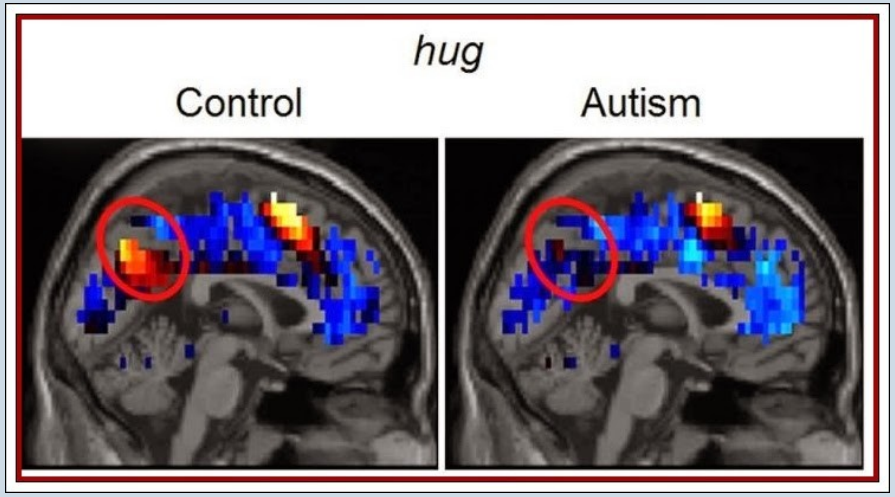
DIFFERENTIATED BY LEVEL OF SUPPORT NEEDED

Severity	Social Communication
Level 1 “Requiring support”	Without supports in place, deficits in social communication cause noticeable impairments.
Level 2 “Requiring substantial support”	Marked deficits in verbal and nonverbal social communication skills; social impairments apparent even with supports in place; limited initiation of social interactions; and reduced or abnormal responses to social overtures from others.
Level 3 “Requiring very substantial support”	Severe deficits in verbal and nonverbal social communication skills cause severe impairments in functioning, very limited initiation of social interactions, and minimal response to social overtures from others.

SEEING THE WORLD DIFFERENTLY

BASIC ASSUMPTIONS ABOUT AUTISM

Autistic individuals learn and act differently because their brains function differently



Just et al. (2014) *PLOS One*

BRAINS CHANGE IN RESPONSE TO ENVIRONMENTAL INPUT

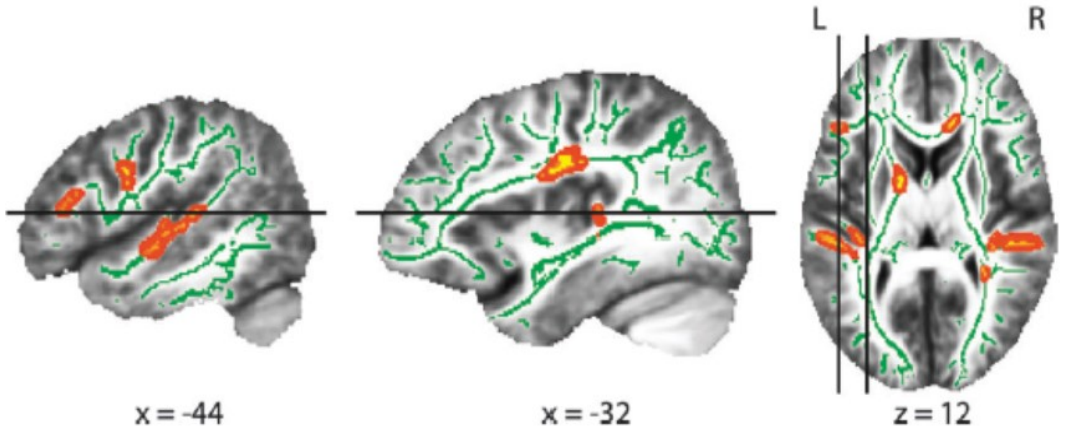


Figure 1. TBSS results for differences between adults and children. The figure represents a mean FA image with the white matter skeleton superimposed (in green). Regions of significant differences between groups are highlighted in red and filled into the local tract region of the mean FA image. They indicate lower FA in children compared with adults ($P < 0.05$, corrected) in the underlying white matter skeleton. Differences between groups are particularly found in Broca's (IFG) and Wernicke's language regions (STG/STS down to the MTG). The figure is displayed in 2 sagittal views and 1 axial view. Lines indicate location of the corresponding sections.

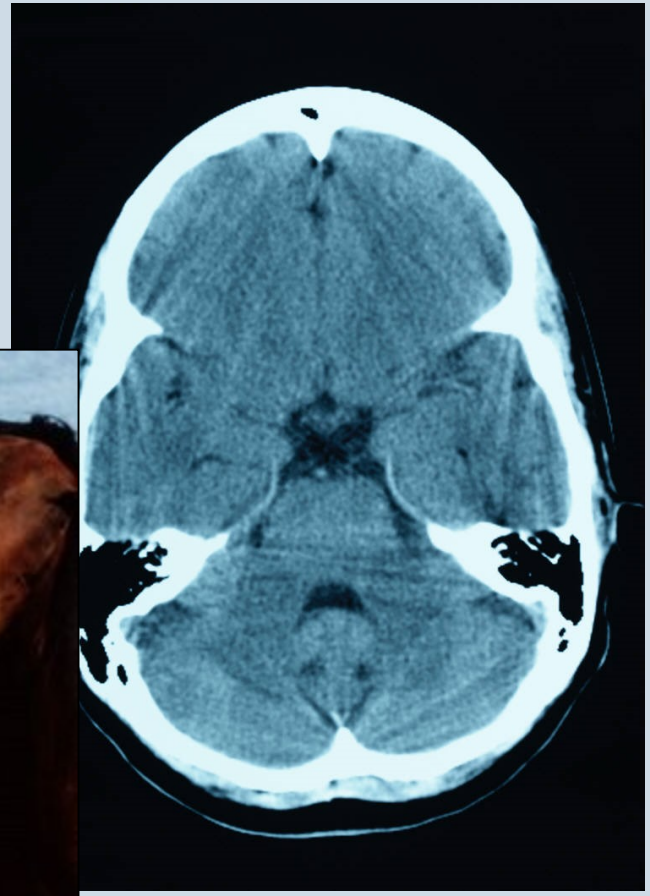
Differences in white matter tracts between 10 seven-year-old children and 10 adults

TBSS= Tract-Based Spatial Statistics

Brauer et al. (2011)

IN AUTISM

The way the brain responds to environmental input can result in a cascade of challenges in learning and social functioning

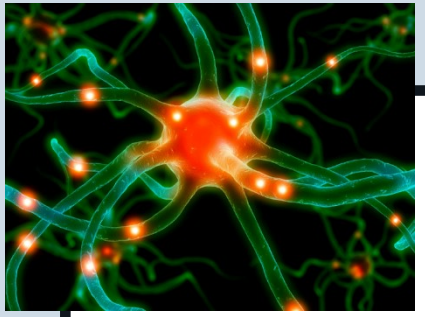


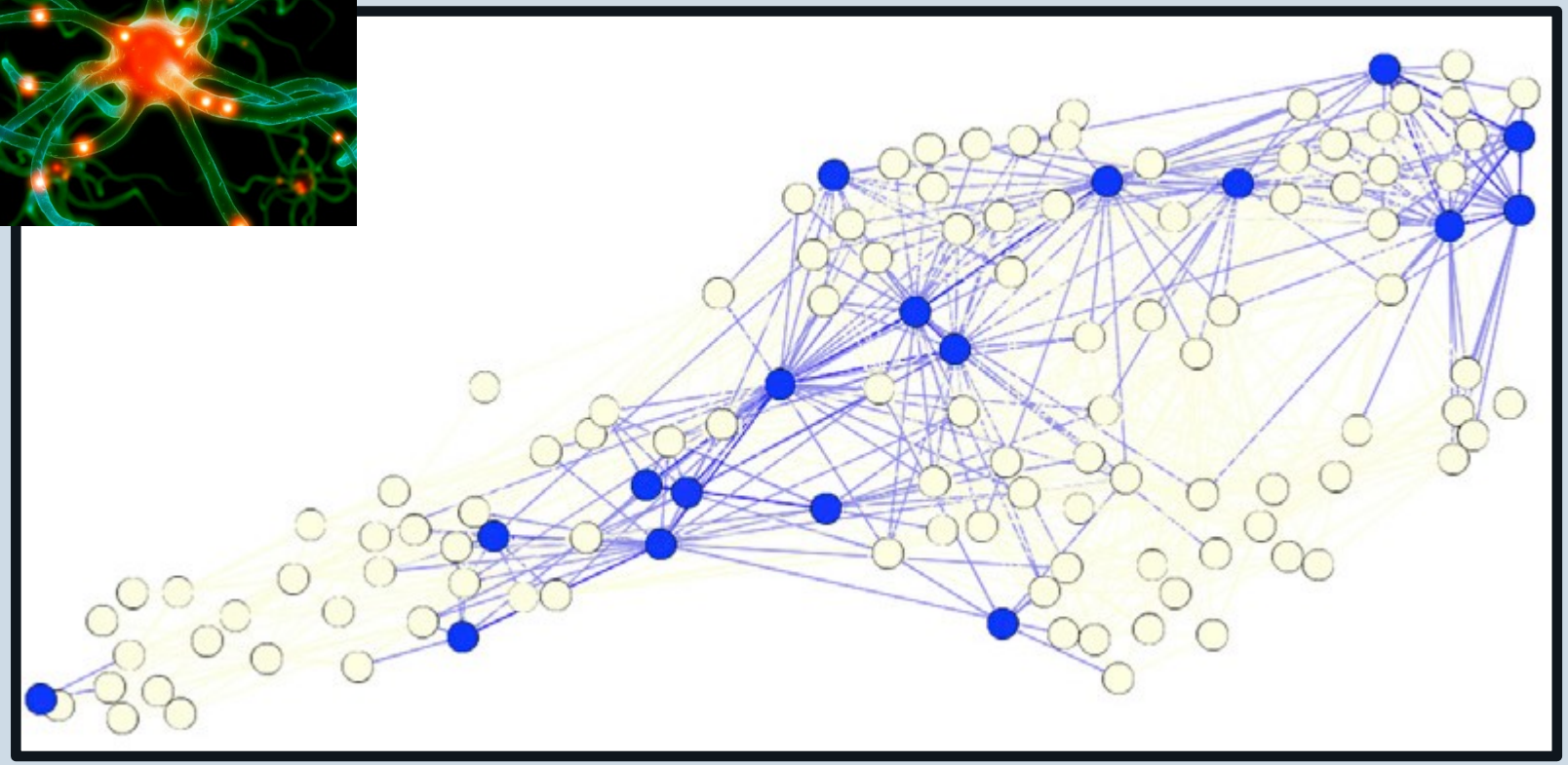
The way the brain of an autistic individual takes in and processes information can also result in some unique contributions and insights

FROM ‘DEVELOPMENTAL DISORDER’ TO NEURODIVERGENCE

“. . . autism may be considered a difference (‘neurodivergence’) that constitutes a disability in the context of the demands of the neurotypical world” (Happé & Frith, 2020)

AUTISM AS A NEURAL SYSTEM DIFFERENCE





From Siugzdaite, Bathelt, Holmes, & Astle (2020)

DISRUPTED CONNECTIVITY HYPOTHESIS OF AUTISM

Differences in connectivity have been reported:

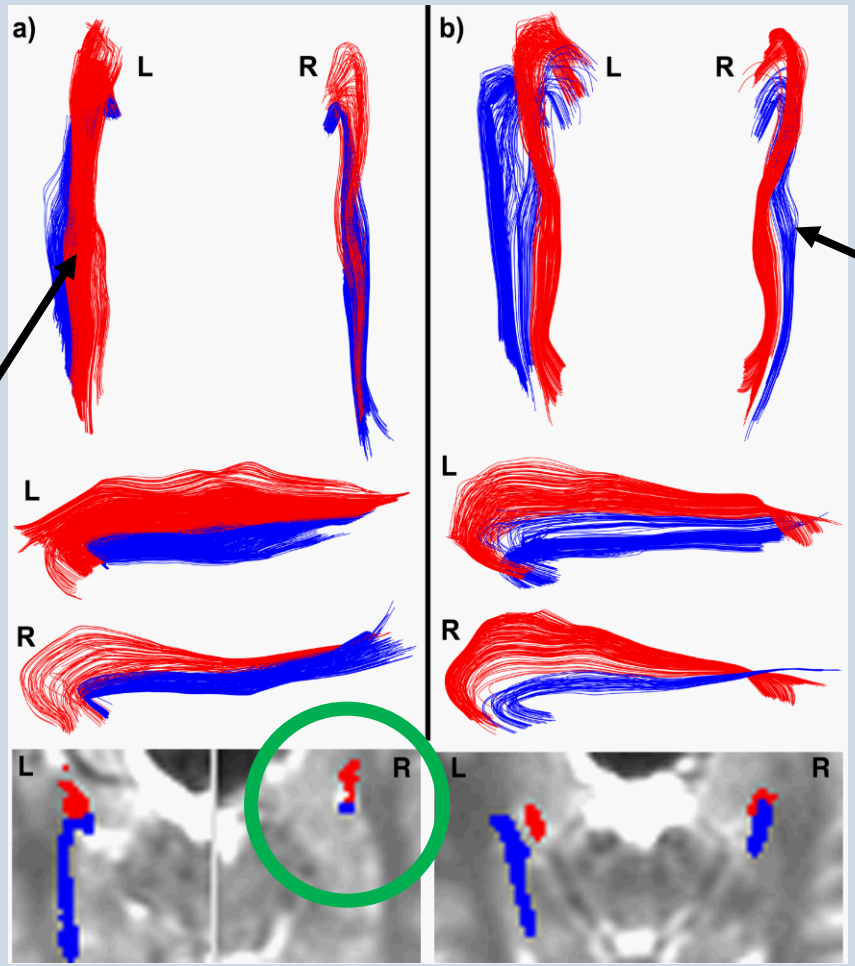
- At the level of the neuron
- Structurally, in white matter pathways
- Functionally, during cognitive processing between key regions
- Functionally, in resting state networks
- Across multiple large-scale brain networks

(e.g., Guo et al., 2024; Minshew & Williams, 2007; Trapani et al., 2022; Uddin, Supekar, & Menon, 2013; Williams et al., 2013)

DTI DATA FROM PARTICIPANT PAIR #7

Autism Non-Autism

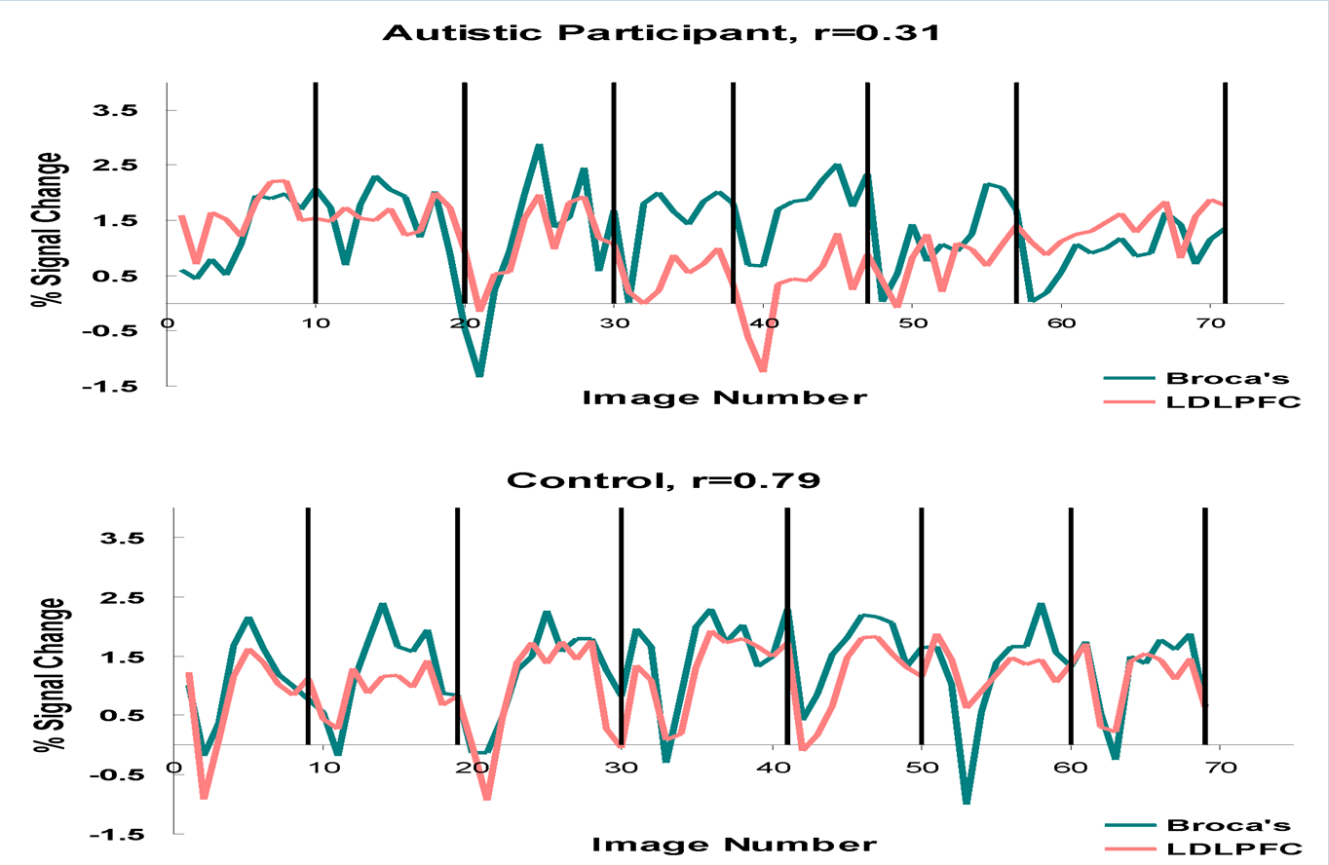
Red = Amygdalo-fusiform pathway

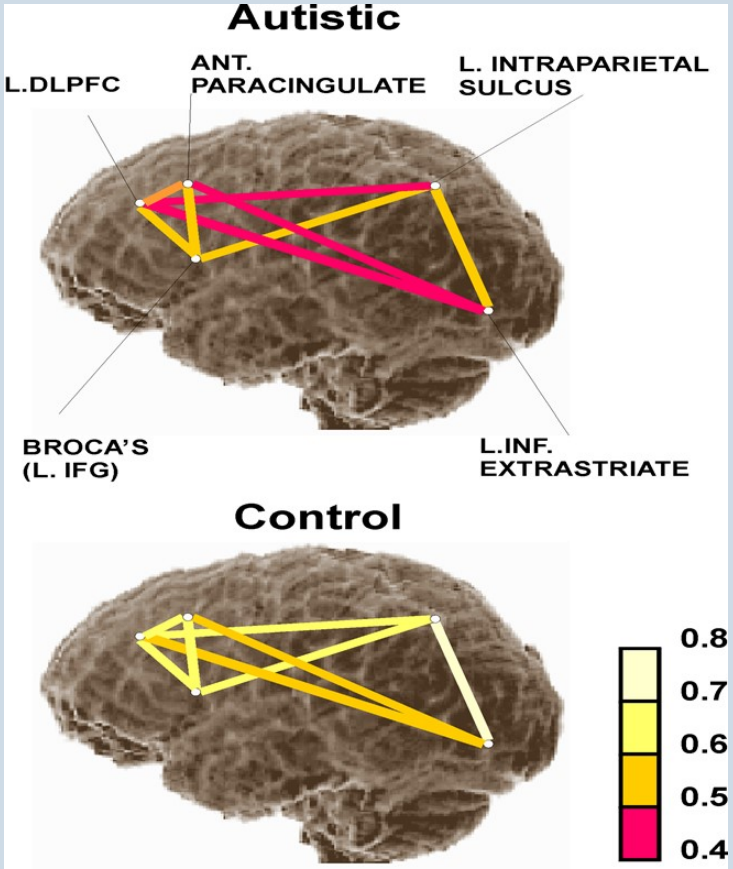


Blue = Hippocampo-fusiform pathway

Conturo et al. (2008)

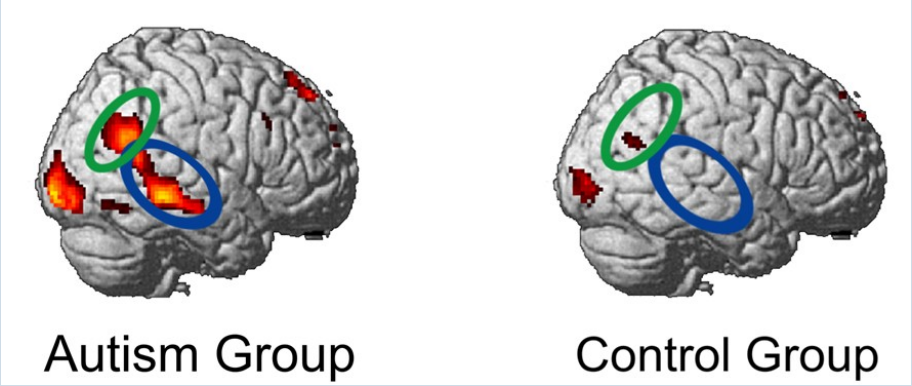
FUNCTIONAL CONNECTIVITY





Just et al. (2004)

- Networks underlying basic abilities are intact
- These networks are relied upon to perform tasks usually performed with more highly integrative network



fNIRS: Coordination of Brain Responses

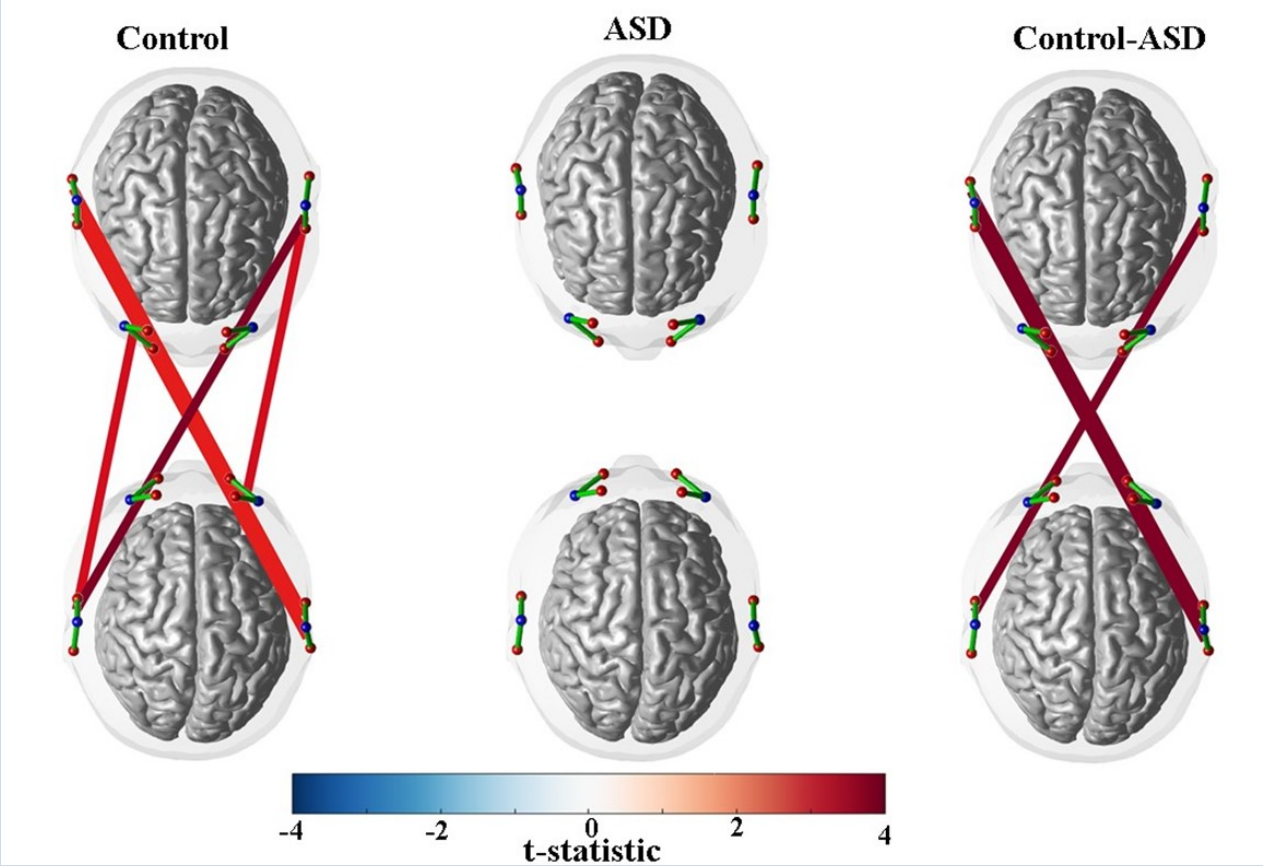


FIGURE 1 (a) Mean inter-subject synchronization for the conversational task relative to the null distribution derived from permutation testing. (b) Comparisons of inter-subject synchronization between the two groups

- Autistic participants had more difficulty coordinating brain responses during a conversation with an interacting partner
- The level of coordination in brain responses was linked to challenges with social communication as measured by the Social Responsiveness Scale

Quiñones-Camacho et al. (2021)

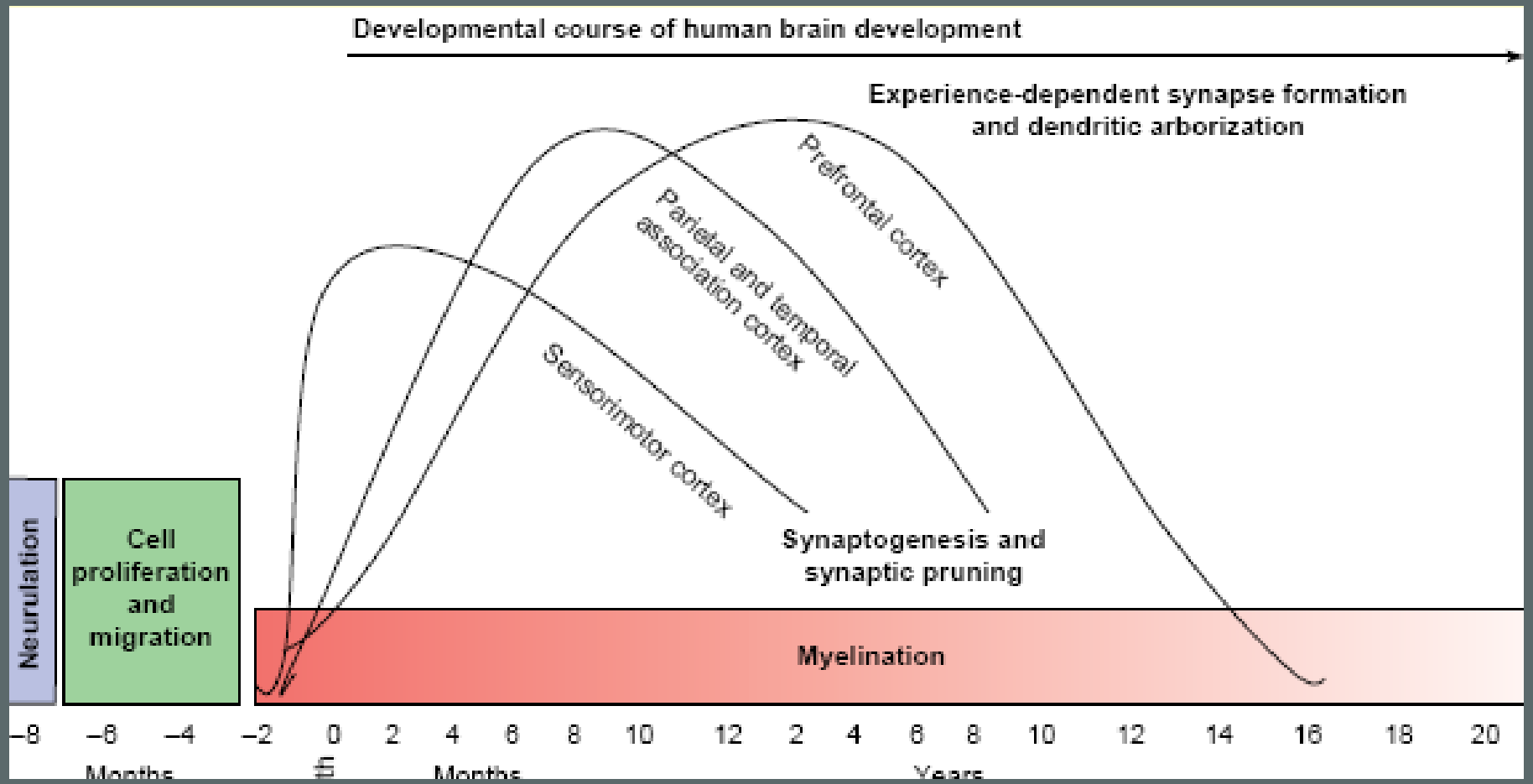
MANY DIFFERENT ROUTES

autism is a behavioral diagnosis that may or may not represent a shared underlying neurology

(Happé & Frith, 2020)

TYPICAL BRAIN DEVELOPMENT

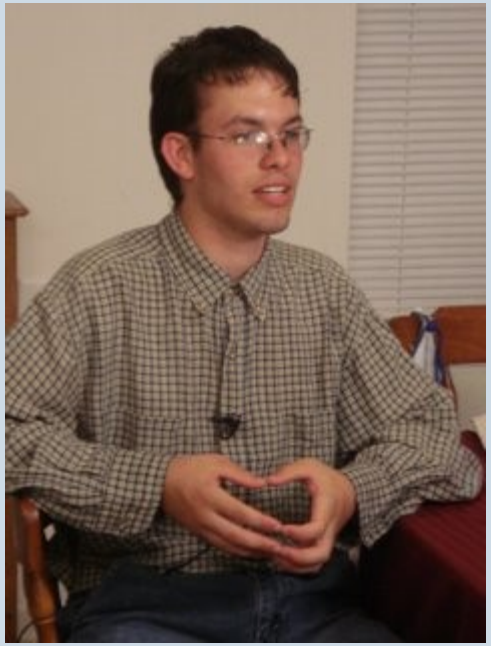
The brain is organized in response to environmental input during the early years of a child's life.



Casey, Tottenham, Liston, & Durston (2005) *Trends in Cognitive Sciences*; Adapted from Thompson & Nelson (2001) *American Psychologist*

AUTISM IS A DEVELOPMENTAL DIFFERENCE

And, the presentation of autism is different at different ages



COMPLEX INFORMATION PROCESSING MODEL OF AUTISM

Intact Abilities

- Attention
- *Sensory Perception*
- Elementary Motor
- Simple Memory
- **Formal Language**
- Rule-Learning
- Visuospatial Processing

Cognitive Differences

- Complex Sensory
- Complex Motor
- Complex Memory
- **Complex Language**
- Concept formation
- Face recognition

Williams, Goldstein, & Minshew, 2015, 2006; Minshew, Goldstein, & Siegel, 1997

NEUROCOGNITIVE MODEL OF AUTISM
COMPLEX INFORMATION PROCESSING (CIP)

- Because of neurobiological differences, autism is **dynamically realized** as the autistic person processes information

- Challenges occur when there is a **mismatch** between cognitive resources and the demands of the processing task increase

NEUROCOGNITIVE MODEL OF AUTISM

(Minshew & Williams, 2007)

↓ performance

when

↑ complexity of the information processing task

Increasing difficulty as the number of cognitive processes demanded by a task increases is not unique to autistic individuals

- Autistic individuals are challenged **at lower levels of complexity** than expected relative to age and general ability level
- Assumption: They accomplish tasks using different processing strategies than expected
- They may also experience high levels of anxiety that interfere with efficient cognitive processing (White et al., 2014)

WHAT DOES THE TERM "COMPLEXITY" MEAN AS USED IN THE MODEL?

Various types of information can be complex:

- Large amounts of information.
- Information of multiple types that must be integrated
- Time constraints and/or multiple simultaneous processing demands
- Stress or anxiety

The way that we are used to conceiving of cognitive abilities and their relationship to behavioral performance may not be an appropriate guide for understanding the learning challenges of autistic individuals

RESULTS OF NEURAL STRUCTURAL AND FUNCTIONAL DIFFERENCES

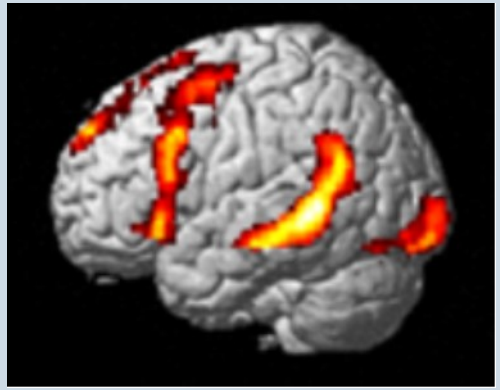
- Create biological constraints

- Autistic individuals experience difficulty
  - meeting the demands for integration of information
  - flexibly responding to changing environmental stimuli

(Beckerson et al., 2022; Minshew, Williams, & McFadden, 2008)

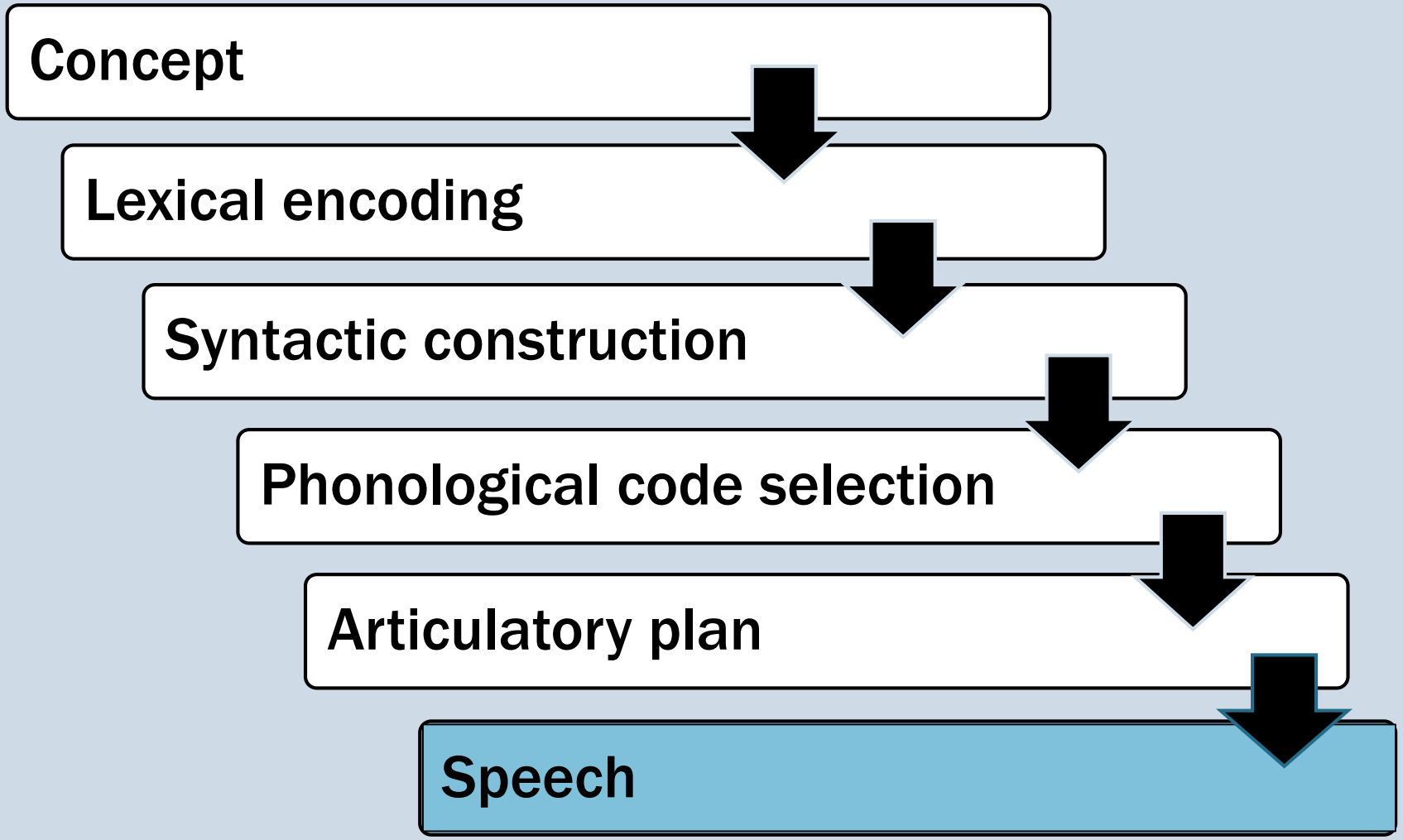
WHY LANGUAGE IS AFFECTED

- Language learning and use is affected because it requires **coordination** across a number of processing centers



- Comprehension and production must be **integrated** with social and/or textual context and **flexibly adapted** to meet those demands

PRODUCTION OF SPOKEN WORDS



Possible reasons WHY an autistic child or adult may not be able to produce spoken words

- May have difficulty with the **perception and or comprehension** of human speech which may result in reduced storage strength or degraded memory trace for words
- May be related to difficulty with **parsing words** from the speech stream
- May be related to difficulty with **mapping** words to objects or other environmental information

- Or, may have difficulty with **retrieving** the stored representation of the word from memory and translating into a string of speech sounds (word-finding or word retrieval)

- Or, may have difficulty with creating the **motor plan** required for spoken word production (dyspraxia)

- Or, may have difficulty with producing the word due to **motor problems** (dysarthria or hypotonia)
- Or, may be storing conceptual knowledge but not automatically **encoding** into language
- Or, the speaking situation may be highly **anxiety** producing making it difficult for them to communicate with mouth words

GESTALT LANGUAGE PROCESSING

- Some autistic individuals may have a different trajectory for learning language that has been referred to *Gestalt Language Processing* (Prizant, 1983; Blanc et al., 2023)
- GLP is thought to be based in episodic memory associated with "gestalt thinking" or difficulty deconstructing the parts from the whole
- GLP is an indicator of a difference in neurofunction and the resultant processing of information

Questions/Comments?

INSIGHTS INTO HOW AUTISTIC INDIVIDUALS PROCESS SOCIAL INFORMATION

LANGUAGE LEARNING IN INFANTS

Occurs through a combination of computational, cognitive, and social skills that reduce the cognitive processing load

(Kuhl, 2010)

AUTISM: DIFFERENCE IN PROCESSING OF SOCIAL INFORMATION

Behavioral, evoked response potential, and neuroimaging evidence is converging to suggest that autistic individuals have a difference in **innate preferential processing of social information**

Carter, Williams, Lehman, & Minshew (2012) *PLOS One*
Eyler et al. (2012) *Brain*
Gervais et al. (2004) *Nature Neuroscience*
Jones & Klin (2013) *Nature*
Shultz,Klin, & Jones (2018) *Trends in Cognitive Sciences*

VISUAL ATTENTION AND LANGUAGE

- Eye-tracking studies:
  - Behavior being investigated as an early identifier for autism
  - For TD: Visual attention to eyes and mouth in year 1 predict receptive language development in year 2
  - For AUT: Patterns of visual fixation were unrelated to language scores but were related to severity of autism

(Koirala et al., 2020)

JAMA | Original Investigation

Eye-Tracking–Based Measurement of Social Visual Engagement Compared With Expert Clinical Diagnosis of Autism

Warren Jones, PhD; Cheryl Klaiman, PhD; Shana Richardson, PhD; Christa Aoki, PhD; Christopher Smith, PhD; Mendy Minjarez, PhD; Raphael Bernier, PhD; Ernest Pedapati, MD; Somer Bishop, PhD; Whitney Ence, PhD; Allison Wainer, PhD; Jennifer Moriuchi, PhD; Sew-Wah Tay, PhD; Ami Klin, PhD

Eye-tracking test results correlated with expert clinical assessments of individual levels of social disability (r = −0.75 [95% CI, −0.79 to −0.71]), verbal ability (r = 0.65 [95% CI, 0.59 to 0.70]), and nonverbal cognitive ability (r = 0.65 [95% CI, 0.59 to 0.70]).

CONCLUSIONS AND RELEVANCE In 16- to 30-month-old children referred to specialty clinics, eye-tracking–based measurement of social visual engagement was predictive of autism diagnoses by clinical experts. Further evaluation of this test's role in early diagnosis and assessment of autism in routine specialty clinic practice is warranted.

(Jones et al., 2023)

IMPLICATIONS OF LACK OF PREFERENTIAL PROCESSING OF SOCIAL INFORMATION

- Effects of autism occurring long before the behavioral signs
- Early identification essential for the most effective remediation

SOME OF THE PROCESSES THAT ARE IMPORTANT FOR LEARNING LANGUAGE

- Preferential processing of human speech
  - Important for auditory comprehension
- Automatic verbal encoding of information
  - Important for conversion of thoughts into words

PREFERENTIAL PROCESSING OF HUMAN SPEECH

PREFERENTIAL PROCESSING OF HUMAN SPEECH

Behavioral studies have demonstrated that newborn infants ***prefer human voices***
(Ecklund-Flores & Turkewitz, 1996; Hutt et al., 1968)

And ***prefer their mother's voice***
(DeCasper & Fifer, 1980)

RESPONSE OF AUTISTIC ADULTS TO HUMAN VOICES

(Gervais et al., 2004)

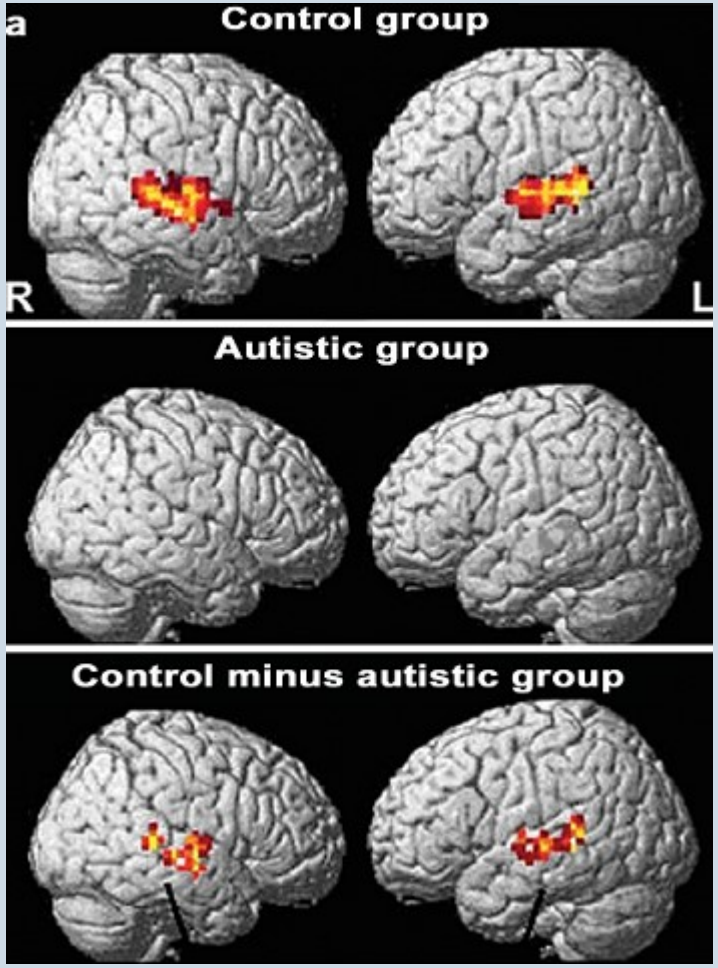
An fMRI study compared responses to:

vocal sounds (speech + nonspeech vocal) and

nonvocal sounds

in male adults with autism and TD male controls

VOICE VS. NONVOICE



Unlike the controls with TD, adult males with autism did not have differential activation in bilateral STS for the voice vs. nonvoice comparison

Suggests that the adults with autism did not innately preferentially process human speech versus other auditory stimuli

(Gervais et al., 2004)

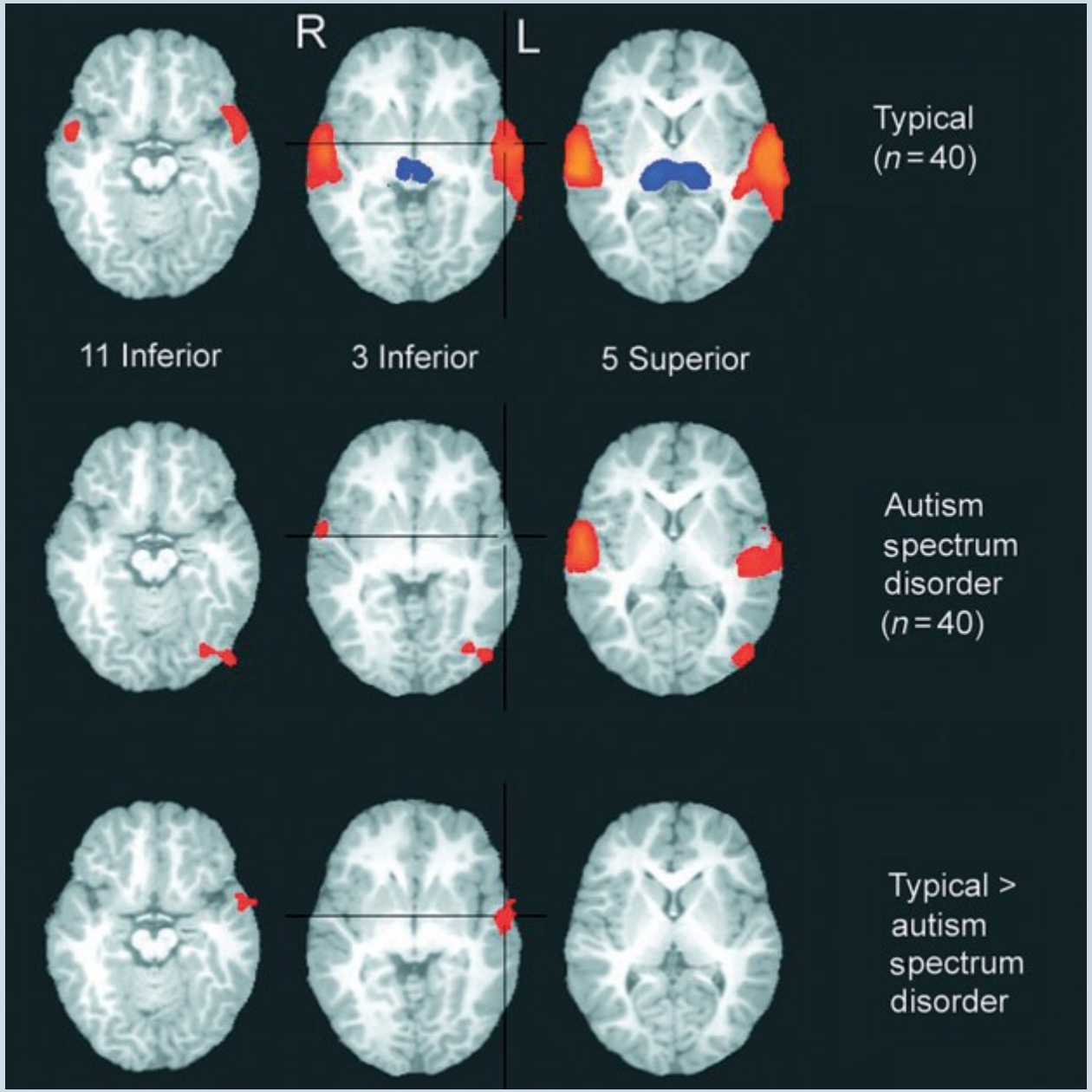
EVIDENCE FROM TODDLERS WITH AUTISM

(Eyler et al., 2012)

- fMRI study with 1 to 4 year olds with (later diagnosed) and without autism during sleep
- 40 children with autism and 40 without
- 3 Conditions when listening to story:
  - Complex forward speech
  - Simple forward speech
  - Backward speech

Children with autism:

- Abnormal left hemisphere response to speech sounds
- Abnormal right-lateralized temporal cortex response to language

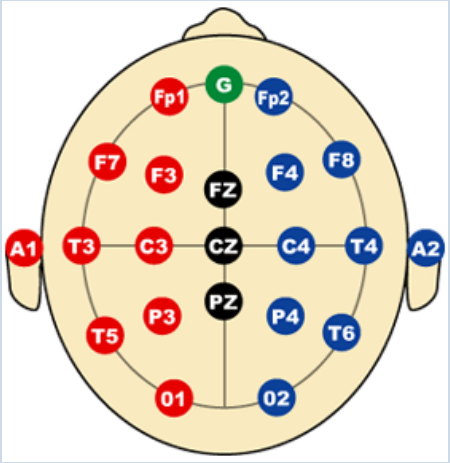


Response to human speech— vs. non stimulation

(Eyler et al., 2012)

PRESCHOOL CHILDREN WITH AUTISM

- Preferred to listen to non-speech vs. 'motherese' speech
- Preference correlated with children's ERP brain responses to speech and severity of ASD
- And failed to demonstrate a significant brain response (mismatch negativity) to a syllable change



(Kuhl et al., 2005)

SCHOOL-AGE AUTISTIC CHILDREN

- Autistic children (N = 20, mean age = 5.8 years)
- Nonautistic peers (N = 20, mean age = 6.5 years).
- Presented with stimuli with systematically decreasing linguistic relevance:
  - naturalistic native speech,
  - meaningless native speech with scrambled word order
  - nonnative speech, and
  - music
- fNIRS results: Both groups showed left lateralization in the temporal lobe when listening to naturalistic native speech
- Nonautistic comparison group demonstrated a systematic reduction in left lateralization as linguistic relevance decreased
- autism group displayed no such pattern and showed no lateralization when listening to scrambled native speech accompanied by enhanced response in the right hemisphere

(Lai et al., 2023)

OTHER DIFFERENCES IN PROCESSING OF HUMAN SPEECH

Autistic adults have greater challenges in processing speech in noisy conditions that are reflected in differences in neurofunctional measures

(Schelinski & von Kriegstein, 2023)

SUMMARY

- Neurofunctional research shows that autistic children and adults have
  - Differences in preferential processing of human speech
  - Differences in patterns of lateralization when processing human speech
  - Differences when processing human speech under challenging conditions such as noise

How might these processing differences affect auditory comprehension?

Questions/Comments?

IMPLICATIONS FOR INTERVENTION WITH AUTISTIC CHILDREN

BRAIN DEVELOPMENT RELATED TO LANGUAGE ACQUISITION

- Guided by genetic codes for neurobiological structure, function, and timing of development
- BUT this neurofunctional development occurs interactively in response to environmental input

(Kolb & Wishaw, 1998)

FOR CHILD WITH AUTISM

Response of the brain may be affected by the underlying neurofunctional differences

(Karmiloff-Smith, 1998)

ASSUMPTIONS ABOUT TEACHING/INTERVENTION

- A teacher/therapist CANNOT directly change the way the brain of a child with autism learns or processes language

- A teacher/therapist CAN change the environmental input to accommodate processing differences

ATTENDING TO SPEECH

Reduce competing auditory information as much as possible → human voice needs to be obvious point of attention

(e.g., Nguyen, 2006)

PERSONAL FM SYSTEMS AND AUDITORY TRAINERS

- Reduce the interference of background noise and increase on-task listening behaviors in the classroom

  (Schafer et al., 2013; Smith et al., 1985)

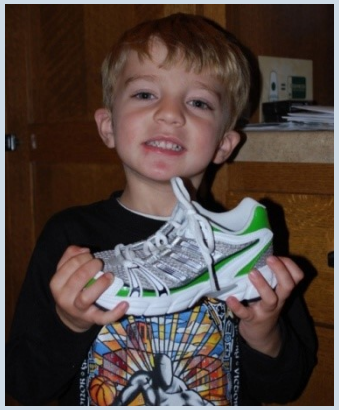
- FM systems should be fitted and monitored following the relevant professional guidelines

  (ASHA, 2002)

LEARNING NEW WORDS

Clearly pair language with what the words are referring to

(Parish-Morris et al., 2007)



MAKING THE CONNECTION

- Make sure the child is attending or handling the object as it is named
- Child may not use perceptual cues such as shape and may focus on other parts of an object

(Tek et al., 2008)

ADAPTING ENVIRONMENTAL INPUT TO INCREASE LANGUAGE COMPREHENSION

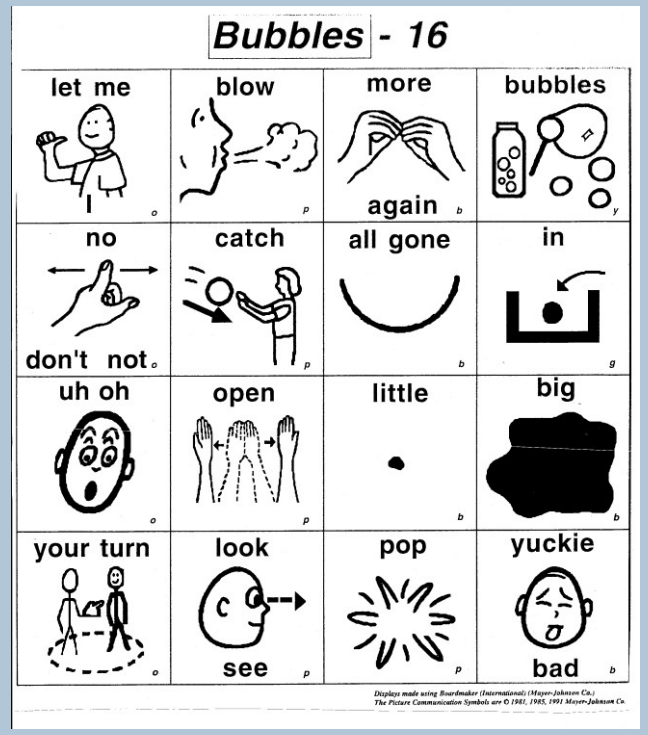
- Need to use with children who have extreme difficulty with decoding and attaching meaning to the spoken language they hear
- Visual input may help them to process spoken language input
- Use of picture symbols may help the child to understand that an object can be associated with a referent

SPECIFIC TECHNIQUE: AIDED LANGUAGE STIMULATION

- Method by which an adult pairs a spoken word with a point to a visual representation of the word

- Used to improve the child's ability to comprehend the language directed to him/her

Logan et al. (2022)
Drager et al. (2006)
Goossens', Crain, & Elder (1992, 1994)

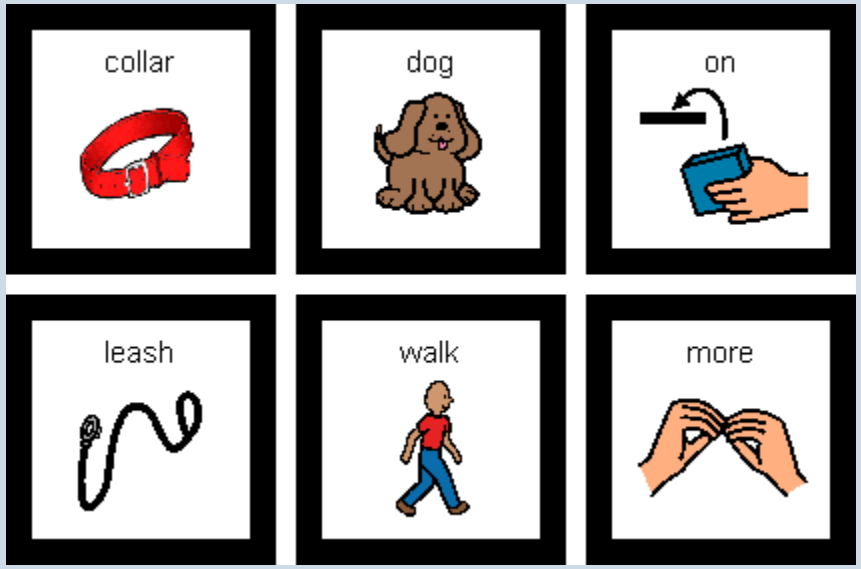


Note: May need to use fewer symbols for some children who have trouble processing multiple stimuli

Visual representations are presented on boards of between 6 to 20 pictures with vocabulary related to a specific activity

Goossens', Crain, & Elder (1994)

6 SYMBOL BOARDS FOR *DOG* THEME



(Hall, A., Master's Thesis, Duquesne University, 2014)

TABLET TECHNOLOGY

Activity specific displays may also be created using Proloquo2go

http://www.assistiveware.com/product/proloquo2go

Image from: http://www.vanderbilt.edu/magazines/peabody-reflector/2014/03/me-myself-and-ipad/

Based on research of Dr. Ann Kaiser, Vanderbilt University

Before using this method, need to establish the child's understanding of **representation:**

- Object
- Photograph
- Colored line drawing
- Black and white line drawing
- Picture symbol

VISUAL SUPPORTS FOR OLDER CHILDREN

Video-modeling with text support

- https://www.youtube.com/watch?v=WFh0hj6hgm0

By: Dr. Tara Zimmerman

Questions/Comments?

Questions about Specific Cases?

EVIDENCE FOR DIFFICULTY WITH VERBAL ENCODING OF INFORMATION IN AUTISM

REPRESENTATION OF CONCEPTS

Individuals are thought to represent concepts both through mental imagery and through verbal representation

(Paivio, 1990)

AUTOMATIC VERBAL ENCODING OF INFORMATION

Individuals with expected development use **automatic verbal coding of information** to reduce the cognitive processing load when managing large amounts of information

Wolford et al. (2000)

AUTOMATIC VERBAL ENCODING OF INFORMATION

- Allows us to share ideas with others
- Facilitates generalization of previously learned information to new contexts

(Wolford et al., 2000)

AUTOMATIC VERBAL ENCODING
A Left Hemisphere Language "Interpreter"

- Gazzaniga proposed that the LH language regions ("the interpreter") are automatically engaged to interpret stimuli and assimilate them into comprehensible events (Wolford et al., 2000)

- This automatic story-telling allows for elaboration and generalization of information such that the LH creates "order from chaos"

BEHAVIORS CONSISTENT WITH DIFFICULTY WITH VERBAL ENCODING IN AUTISM

- Lateness to talk
- Persistent minimal use of speech
- Difficulty with word retrieval
- Difficulty with creating a spoken narrative

NEURO-SIGNATURE OF VERBAL ENCODING OF INFORMATION

- In fMRI, this encoding is demonstrated by the use of a left hemisphere network including language areas during verbal working memory tasks (Smith et al., 1998)

- What do fMRI studies tell us about autistic individuals?

N-BACK WORKING MEMORY TASK

(Koshino et al., 2005)

500 ms

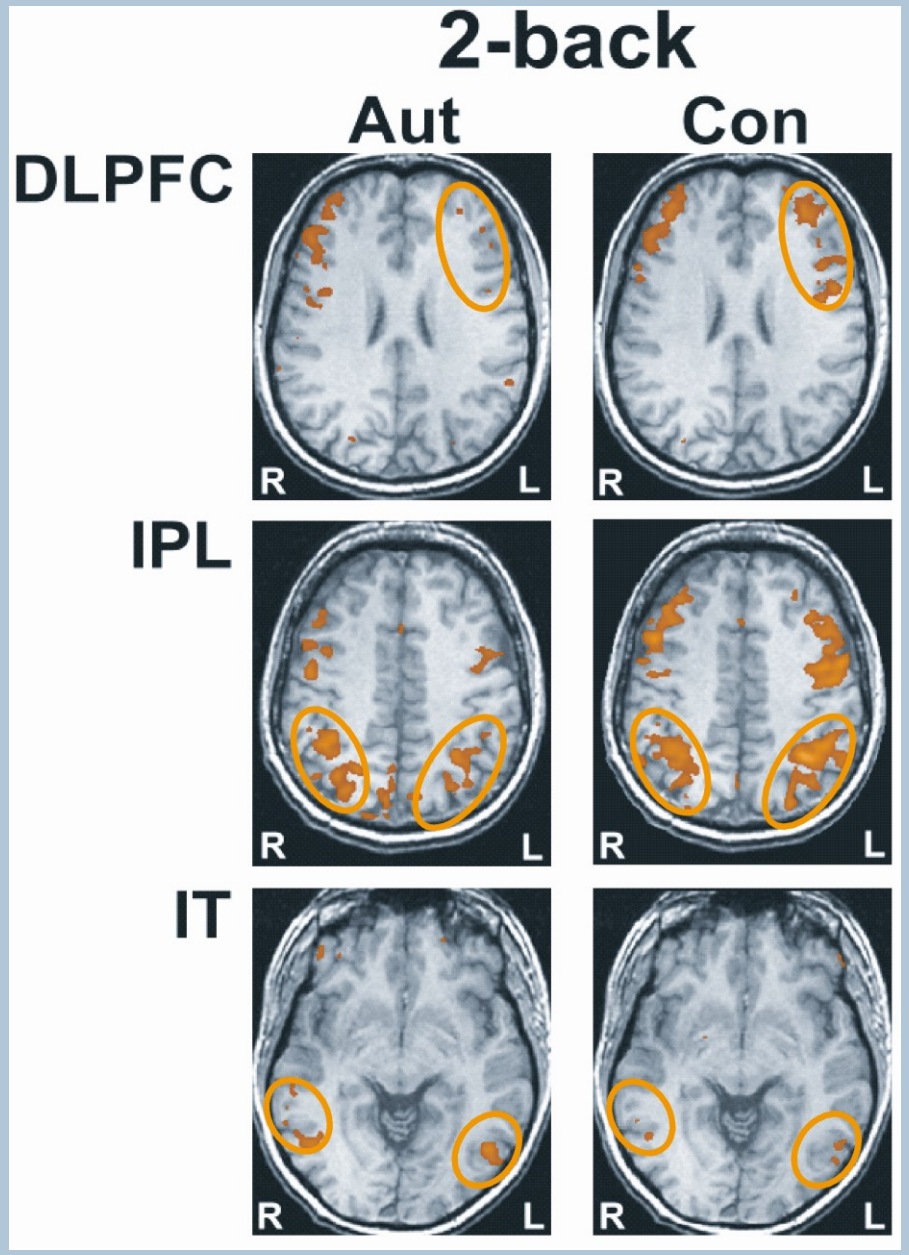
1 back

H		G		A		A

1000 ms

2 back

H		G		A		G

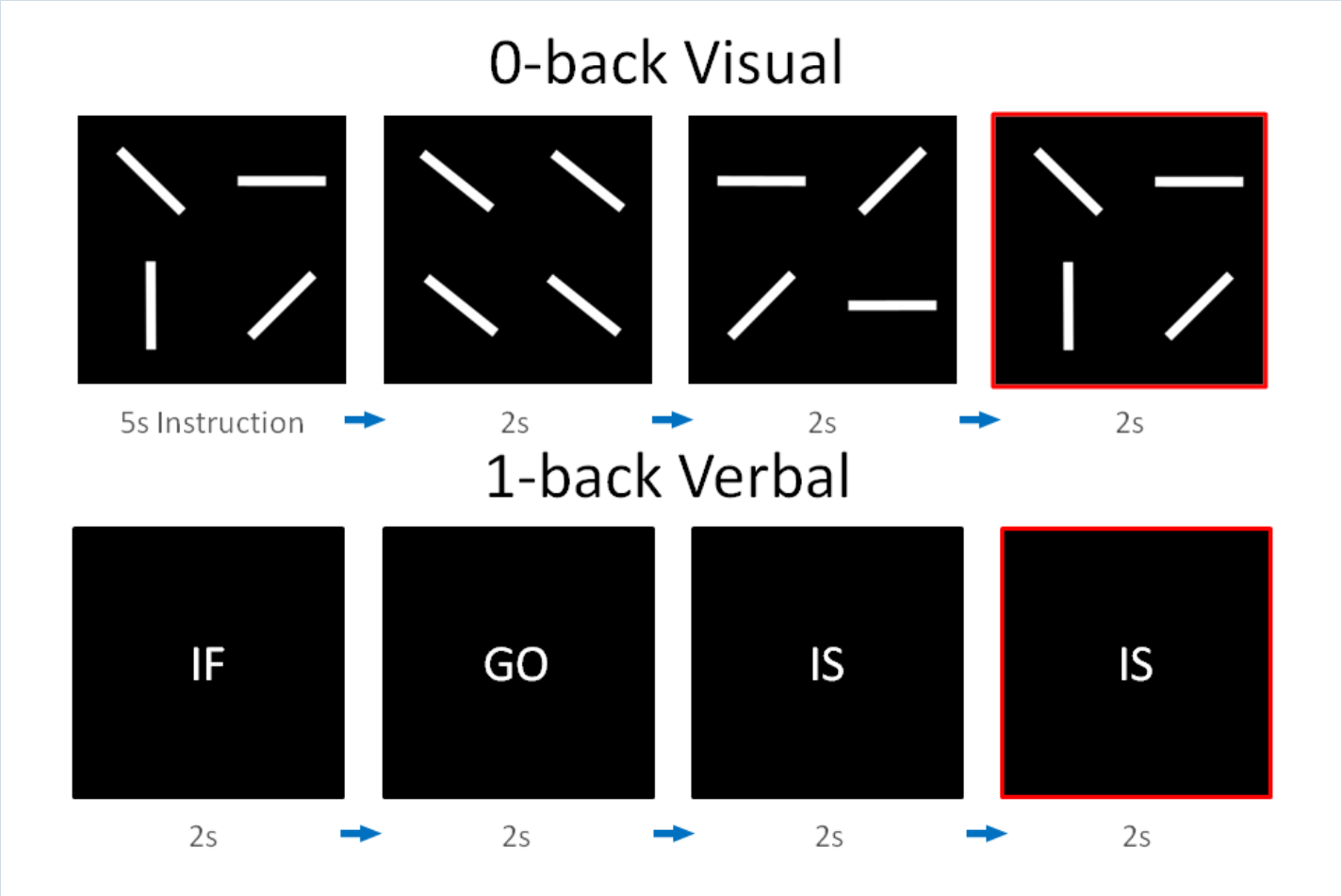


Individuals with ASD used a right hemisphere working memory network while controls used the expected left hemisphere working memory network

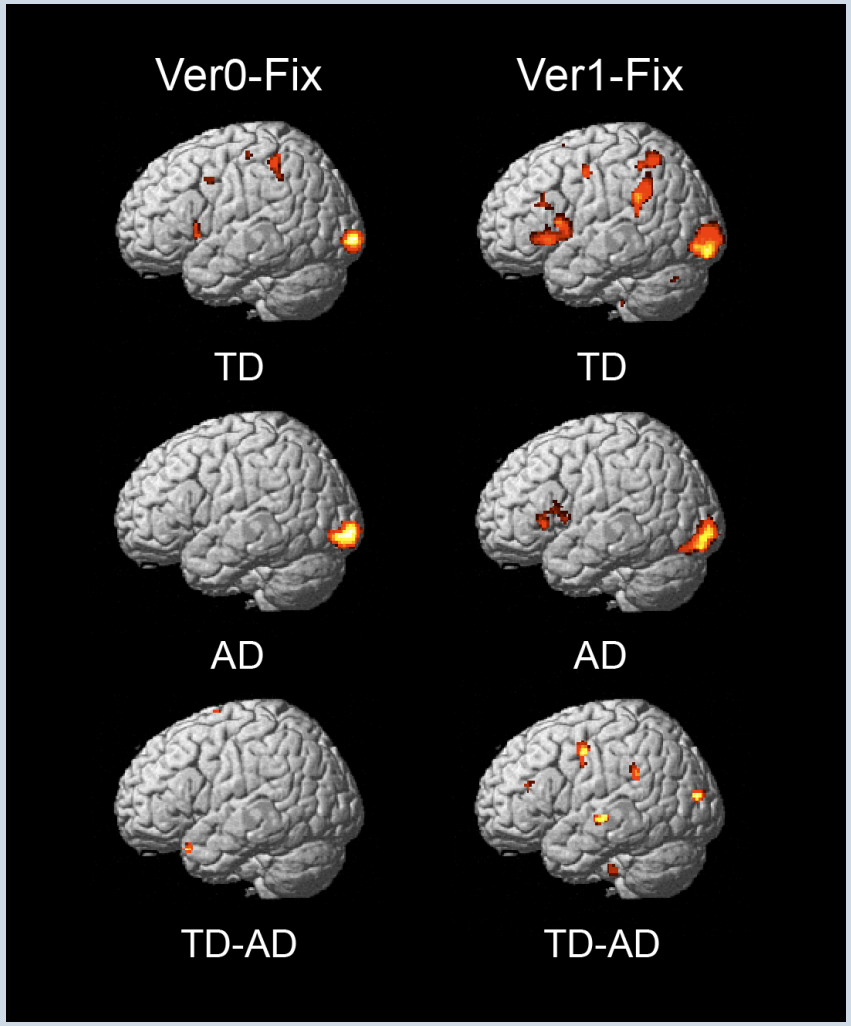
Koshino et al., 2005

N-BACK WORKING MEMORY TASK WITH 2-LETTER WORDS

(Carter, Williams et al., 2012b)



N-BACK WORKING MEMORY TASK WITH 2-LETTER WORDS



(Carter, Williams et al., 2012b)

CONCLUSION FROM VERBAL WORKING MEMORY STUDIES

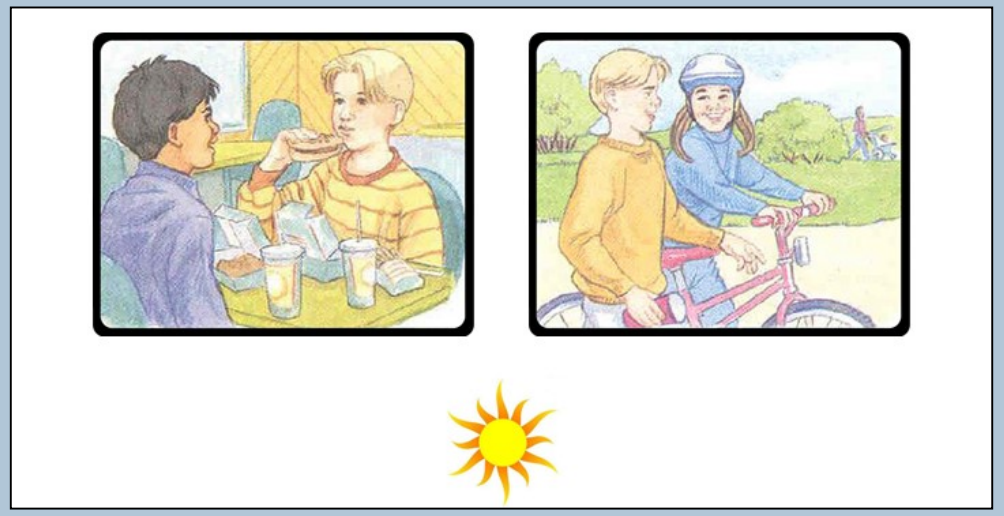
- Both the adults and children with autism relied more on visual strategies to perform the two-letter working memory tasks
- The TD groups primarily used linguistic strategies, indicated by the level of activation of Broca's area

SOCIAL & PHYSICAL JUDGMENT TASKS

(Carter et al., 2012a)

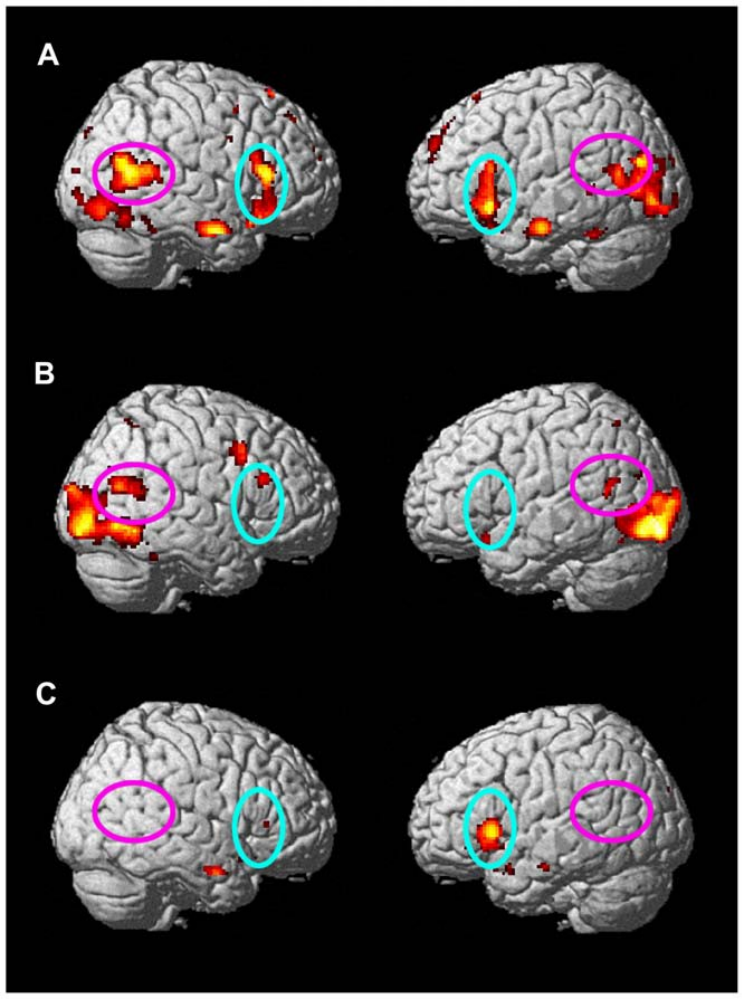
Social

Physical



COMPARISON OF PERFORMANCE WHEN MAKING JUDGMENTS

- TD Social > Physical
- Aut Social > Physical
- TD-Aut Social > Physical



(Carter et al., 2012a)

- Even though language was unnecessary, the children with TD recruited language areas during the social judgment task
- This suggested automatic encoding of their knowledge into language
- However, this was not the case for the children with autism

(Carter et al. 2012a)

WHAT THESE STUDIES SUGGEST

Children and adults with autism have difficulty with the automatic verbal encoding of visually-presented information

RECALLING EXPERIENCES

This result is consistent with earlier behavioral work that proposed that the failure of individuals with autism to recode experiences into language was an underlying cause of difficulty with recalling experiences and difficulty with generalization of knowledge

(Boucher, 1981)

EVIDENCE CONSISTENT WITH CHALLENGES WITH VERBAL ENCODING

Speech-generating or voice output devices increase production of spoken language

(Ganz et al. 2012)

Image from: http://www.vanderbilt.edu/magazines/peabody-reflector/2014/03/me-myself-and-ipad/
Based on research of Dr. Ann Kaiser, Vanderbilt University

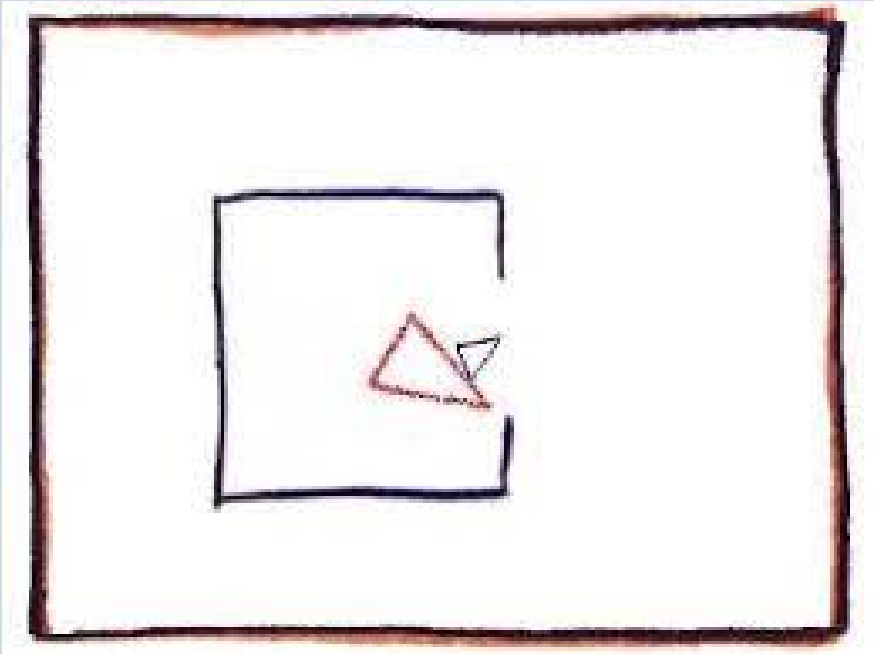
VERBAL VS. VISUOSPATIAL RETELL

Brief Report: Visuospatial and Spoken Language Recall in Autism: Preliminary Findings.

Coburn KL [1], Williams DL [1]

Author information

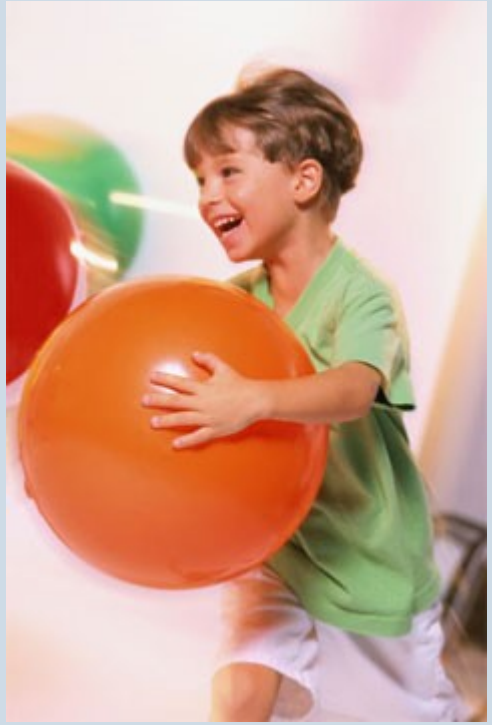
Journal of Autism and Developmental Disorders, 28 Jun 2021, 52(6):2831-2837
https://doi.org/10.1007/s10803-021-05143-0 PMID: 34181142



(Coburn & Williams, 2021)

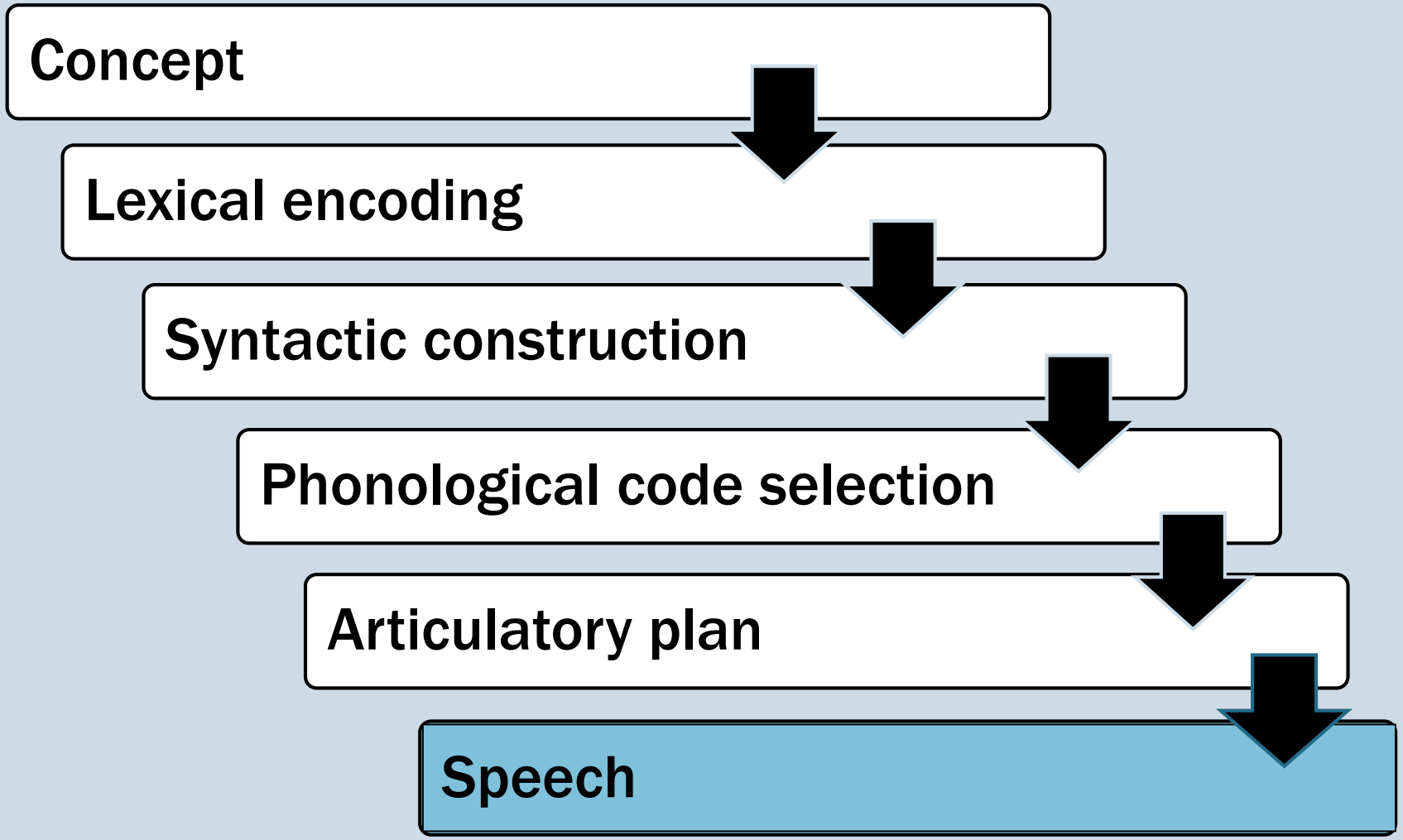
VISUAL STRATEGY

- Would work well as a young child acquires information about novel objects and actions
- Seeing a ball once, the child will recognize it if he sees it again
- However, a visual strategy will make it difficult for the child to produce the word “ball”



Visual strategy will also not work well when large amounts of information must be retained, integrated, and applied to a novel situation

PRODUCTION OF SPOKEN WORDS



If child is storing conceptual knowledge in a **visual form** and not automatically recoding into language, it may interfere with their ability to speak→

- Minimal verbalizations in young or more challenged children
- Word retrieval problems in older, verbal children
- Overuse of pre-encoded “formulaic” utterances
- Periodic need for AAC when mouth words are not forthcoming

PREDICTION

- If bridging the gap between conceptual understanding and verbal formulation is a challenge in autism then

Would predict that

- Interventions that close that gap would be effective in increasing the use of spoken language of autistic individuals

AUGMENTATIVE/ALTERNATIVE COMMUNICATION

A systematic review that included nine single subject and two group design studies found that:

- Use of AAC resulted in gains in speech production for most of the participants with autism

(Schlosser & Wendt, 2008)

TRANSLATING VISUAL INFORMATION INTO VERBAL INFORMATION

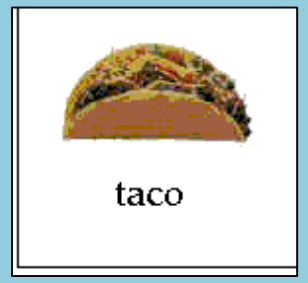
AIDED COMMUNICATION

Example: Picture Exchange Communication Systems
(PECS; Frost & Bondy, 2002; Ganz & Simpson, 2004)

Reminder: Representation needs to be at a level the child can easily understand to reduce the processing load

Picture Exchange Communication System

(PECS; Frost & Bondy, 2002; Ganz & Simpson, 2004)



PICTURE EXCHANGE COMMUNICATION SYSTEM (PECS)

- The pragmatic and visual components of PECS may be important operating variables
- The verbal encoding provided during use may also be an essential, but unrecognized benefit

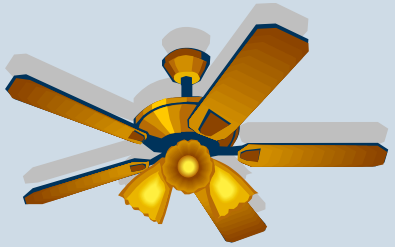
(Frost & Bondy, 2002)

COMMON COMPONENTS OF THESE APPROACHES

- Use of visual depictions of concepts
- Associated verbal encoding provided either by a voice-output device or by the communication partner
- Therefore, visual information is translated into a verbal form
- Autistic individual is invited to put a conceptual thought into a word form

POTENTIALLY IMPORTANT ASPECTS

- Selection of visual content that includes vocabulary that the child *comprehends* but *does not use* in spontaneous spoken words



- Selection of words for high-interest stimuli (Rothwell et al., 2023)

SPEECH GENERATING DEVICES

A meta-analysis of treatment studies indicated that SGDs or voice output devices are effective in increasing the communication skills (and spoken language) in children with ASD

(Ganz et al., 2012)

SYSTEM FOR AUGMENTING LANGUAGE (SAL)
(Romski et al., 2006)

5 integrated components:

1. Select a portable Voice Output Communication Aid (VOCA)
2. Choose visual-graphic symbols and lexicon that are functionally relevant for the child
3. Teach through natural, everyday environments with an emphasis on functional communication exchanges
4. Instruct the communication partners to use the device
5. Monitor ongoing use

PROGRESSING TO TWO-WORD COMBINATIONS

- Early word combinations are based on **word meanings** not grammar
- Are referred to as “semantic relations”
- Build length of utterances by combining word meanings NOT by saying “I want ___.”

TWO-WORD COMBINATIONS

(Bloom, 1970; Brown, 1973; Bowerman, 1975)

- **Object (or Person) + Action**: *daddy ride; car go*
- **Action + Object**: *brush teeth; eat cookie*
- **Demonstrative + Object**: *here cookie; there doggie;* and, *that hat*
- **Negation + Object**: *no bubble*; *no want*; and, *cookie allgone*

- **Animal or Person + Object**: Describes a person acting on an object (“mommy juice” as mom is drinking or “daddy door” as daddy is opening the door)

- **Action + Location**: Describes an action performed in a specific location (“sit chair” as child puts stuffed dog on the chair or “put in” as child puts in a puzzle piece)

- **Object or Person + Location**: Described in a specific location (“mommy home” or “car garage”)

- **Possessor-Possession**: Describes an object owned by a person (“daddy car” as child points to car owned by dad or “mommy hair” as child brushes mom’s hair)

- **Descriptor + Object**: Early form of an adjective (“big ball” as child picks up a ball or “blue car” as child points to car in a book)

- **Recurrence**: To request another occurrence of an action or object (“more juice” or “more jump”)

VERBAL CHILDREN MAY NEED A LANGUAGE MEDIATOR

Because information may not be automatically encoded into language, the adult may need to help the child bridge the gap.

- E.g.: Verbalizing the steps of a procedural task
- E.g.: Verbalizing emotional reactions

VERBAL MEDIATION

- Been successfully used to promote learning of procedural sequences in older children with language-learning disabilities

- Once can verbalize steps, individual with autism can be taught to do the mediation overtly, using "inner speech"

(Laskey, 1991)
(Nathan & Nathan, 2018)

ADDITIONAL THOUGHTS

- Autistic individual may struggle to tell you "what's in their head"
- Help them to construct a narrative version of an experience that can be shared with others rather than expecting self-construction
- Externally create what is typically inner self-talk to regulate behavior
- "Social stories" fit in here (Gray, 2010, *The new social story book)*

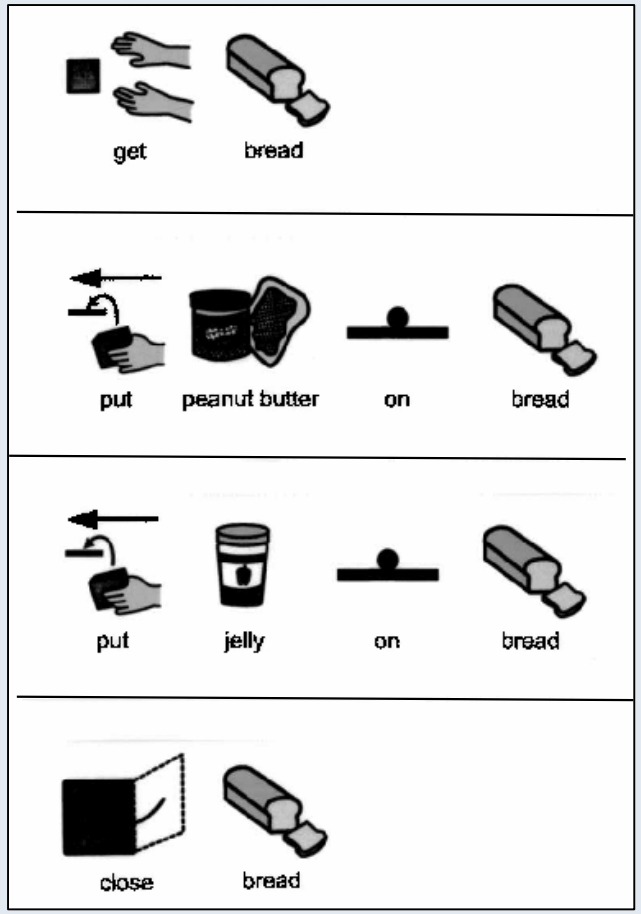
CREATING A NARRATIVE

- Start with what the person knows and has actual experience with→
  - Personal narratives
  - Procedural discourse
- More likely to be able to encode into language because don’t have to create, organize, and produce the words

1) Visual organizer for procedural discourse

2) Picture support for retelling steps of science experiment

3) Graphic organizer for compare/contrast



ADDITIONAL IDEAS

- Photos of the child doing an activity
- Have parent take pictures of child's weekend or other special activities
- Use photo storage capabilities of iPad as "book" for child to share with parent rather than typical picture books

VIDEO MODELING

See Shane et al. (2012)

- Video-modeling with videos made of the child doing the activity
- Videos of a similar activity to help child use words needed for telling about the activity (like retrieved from the Internet) Ex: Homecoming game
- Video-modeling to teach vocational skills (Chen & Yakubova, 2023)

VISUAL SCENE DISPLAYS

See: Light, McNaughton, & Caron (2019. New and emerging AAC technology supports. . . in Augmentative and Alternative Communication

VISUAL SCENE DISPLAYS

YOU HAVE ACCESS | SIG 12 Augmentative and Alternative Communication | Clinical Focus | 5 Apr 2023

Visual Scene Displays for Children and Adults: Using Case Studies to Bridge Research and Clinical Practice

David J. Hajjar and Kathleen Mulkerin

https://doi.org/10.1044/2022_PERSP-22-00162

VISUAL SCENE DISPLAYS

- Scene Speak

https://itunes.apple.com/us/app/scene-speak/id420492342?mt=8

ADDITIONAL CONSIDERATIONS

- Ascertain pre-knowledge of semantic content or pre-teach unfamiliar semantic content so child has the words to express his knowledge/ideas

- “Scripts” may be an indicator of differences in linguistic coding of information and should be honored as such with interpretation according to context/use

WORD RETRIEVAL

- Challenges with verbal encoding may present as challenges with word retrieval in autistic children and adults who speak in connected sentences (Walenski et al., 2006)
- Consider doing an assessment for word-finding
- Consider incorporating treatment for word retrieval strategies into the intervention plan

A WORD ABOUT "MOUTH WORDS"

- Even autistic individuals with a high level of spoken language may have challenges with automatically translating concepts into spoken words or the use of "mouth words" under certain conditions

- These individuals may prefer to use an alternative mode of communication when this occurs

SUMMARY

- Challenges with automatic verbal encoding may interfere with the expressive output of autistic individuals
- Even autistic individuals with a high level of spoken language may have problems with automatically translating concepts into words
- Select strategies for communication that provide a bridge between what the person “knows” and what they are able to express

Questions/Comments?

Applying what you've learned to a specific case

CONCLUSION

TAKE AWAY #1

- The brains of autistic individuals may function in unexpected ways, resulting in differences in learning and behavior
- Therefore, they need changes to be made to their environments and interactions with others to accommodate these differences

TAKE AWAY #2

- Children with autism learn language differently
- Therefore, we need to modify environmental input so that it is "brain-friendly" for them NOT try to make their brains function like that of children without autism
- We need to appreciate their uniqueness

WEB RESOURCES FOR LITERATURE

https://www.scholar.google.com

https://www.ncbi.nlm.nih.gov/pmc/

http://www.ccbi.cmu.edu

https://www.autismspeaks.org/science/science-news/speech-devices-can-help-build-language-schoolchildren-autism

THANK YOU

Diane L. Williams, PhD, CCC-SLP, BCS-CL
Professor and Department Head
Department of Communication Sciences and Disorders
The Pennsylvania State University

For more information:

E-mail: dlw81@psu.ed

REFERENCES

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders: DSM-5.* Washington, DC: Author.

American Speech-Language-Hearing Association. (2002). *Guidelines for fitting and monitoring FM systems* [Guidelines]. Available from www.asha.org/policy.

Beckerson, M. E., May, K. E., & Kana, R. K. (2022). Social, cognitive, perceptual, and other models of autism spectrum disorder. In *The Neuroscience of Autism* (pp. 65-85). Academic Press.

Blanc, M., Blackwell, A., & Elias, P. (2023). Using the Natural Language Acquisition Protocol to Support Gestalt Language Development. *Perspectives of the ASHA Special Interest Groups, 8(6),* 1279-1286.

Bloom, L. (1970). *Language development: Form and function of emerging grammars.* Cambridge, MA: MIT Press.

Boucher, J. (1981). Memory for recent events in autistic children. *Journal of Autism and Developmental Disorders, 11*, 293-301.

Bowerman, M. (1975). Cross-linguistic similarities at two stages of syntactic development. In E. Lenneberg, & E. Lenneberg (Eds.), *Foundations of language development: A Multi-disciplinary approach* (pp. 267-282). New York: Academic Press.

Brauer, J., Anwander, A., & Friederici, A. D. (2011). Neuroanatomical prerequisites for language functions in the maturing brain. *Cerebral Cortex, 21(2),* 459-466.

Brown, R. (1973). *A first language: The early stages.* Cambridge, MA: Harvard University Press.

Carter, E.J., Williams, D.L., Lehman, J., & Minshew, N.J. (2012a). Is he being bad? Social and language brain networks during social judgment in children with autism. *PLOS One, 7,* 1-9.

Carter, E.J., Williams, D.L., Lehman, J., & Minshew, N.J. (2012b). Using visual strategies to remember verbal information: an fMRI study of working memory in children with and without autism. International Meeting for Autism Research, 11, 55 [http://imfar.confex.com/imfar/2012/webprogram/start.html].

Casey, B. J., Tottenham, N., Liston, C., & Durston, S. (2005). Imaging the developing brain: what have we learned about cognitive development? *Trends in Cognitive Sciences, 9,* 104-109.

Chen, B.B., & Yakubova, G. (2023). Evaluating the effects of video-based intervention to teach vocational skills to transition-age youth with autism spectrum disorder: an evidence-based systematic review. *Review Journal of Autism and Developmental Disorders, 10(1)*, 22-37.

Coburn, K. L., & Williams, D. L. (2021). Brief Report: Visuospatial and spoken language recall in autism: Preliminary findings. *Journal of Autism and Developmental Disorders*, 1-7.

Conturo, T.E., Williams, D.L., Smith, C.D., Gultpe, E., Akbudak, E., & Minshew, N.J. (2008). Neural fiber pathway abnormalities in autism: An initial MRI diffusion tensor tracking study of hippocampo-fusiform and amygdalo-fusiform pathways. *Journal of the International Neuropsychological Society, 14,* 933-946.

DeCasper, A.J., & Fifer, W. P. (1980). Of human bonding: Newborns prefer their mothers' voices. *Science, 280,* 1174-1176.

Drager, K. D., Postal, V. J., Carrolus, L., Castellano, M., Gagliano, C., & Glynn, J. (2006). The effect of aided language modeling on symbol comprehension and production in 2 preschoolers with autism. *American Journal of Speech-Language Pathology*, *15*(2), 112.

Ecklund-Flores, L., & Turkewicz, G. (1996). Asymmetric head turning to speech and nonspeech in human newborns. *Developmental Psychobiology, 29,* 205-217.

Eyler, L.T., Pierce, K., & Courchesne, E. (2012). A failure of left temporal cortex to specialize for language is an early emerging and fundamental property of autism. *Brain, 135,* 949-960.

Frost, L., & Bondy, A. (2002). *Picture exchange communication system.* Newark, DE: Pyramid Educational Products.

Ganz, J. B., & Simpson, R. L. (2004). Effects on communicative requesting and speech development of the picture exchange communication system in children with characteristics of autism. *Journal of Autism and Developmental Disorders, 34*(4), 395-409.

Ganz, J. B., Earles-Vollrath, T. L., Heath, A. K., Parker, R. I., Rispoli, M. J., & Duran, J. B. (2012). A meta-analysis of single case research studies on aided augmentative and alternative communication systems with individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *42*(1), 60-74.

Gervais, H., Belin, P., Boddaert, N., Leboyer, M., Coez, A., Sfaello, I., et al. (2004). Abnormal cortical voice processing in autism. *Nature Neuroscience, 7,* 801-802.

Goossens', C., Crain, S., & Elder, P. (1992). Engineering the preschool environment for interactive, symbolic communication. Birmingham, AL: Southeast Augmentative Communication Conference Publications.

Goossens', C., Crain, S., & Elder, P. (1994). *Communication displays for engineered preschool environments: Books 1 and 2.* Solana Beach, CA: Mayer-Johnson Co.

Gray, C. (2010). *The new social story book.* Arlington, TX: Future Horizons.

Guo, Z., Tang, X., Xiao, S., Yan, H., Sun, S., Yang, Z., ... & Wang, Y. (2024). Systematic review and meta-analysis: multimodal functional and anatomical neural alterations in autism spectrum disorder. *Molecular Autism, 15(1),* 1-13.

Hajjar, D. J., & Mulkerin, K. (2023). Visual Scene Displays for Children and Adults: Using Case Studies to Bridge Research and Clinical Practice. *Perspectives of the ASHA Special Interest Groups, 8(2),* 322-336.

Happé, F., & Frith, U. (2020). Annual Research Review: Looking back to look forward–changes in the concept of autism and implications for future research. *Journal of Child Psychology and Psychiatry, 61(3),* 218-232.

Hutt, S.J., Hutt, C., Leonard, H.G., von Bermuth, H., & Muntjewerff, W. F. (1968). Auditory responsitivity in the human neonate. *Nature, 218,* 888-890.

Jones, W., & Klin, A. (2013). Attention to eyes is present but in decline in 2-6-month-old infants later diagnosed with autism. *Nature, 504*, 427-443.

Jones, W., Klaiman, C., Richardson, S., Aoki, C., Smith, C., Minjarez, M., ... & Klin, A. (2023). Eye-tracking–based measurement of social visual engagement compared with expert clinical diagnosis of autism. *JAMA*, *330*(9), 854-865.

Just, M. A., Cherkassky, V. L., Keller, T. A., & Minshew. N. J. (2004). Cortical activation and synchronization during sentence comprehension in high-functioning autism: evidence of underconnectivity. Brain, 127, 1811-1821.

Kana, R. K., Keller, T. A., Cherkassky, V.L., Minshew, N. J., & Just, M. A. (2006). Sentence comprehension in autism: thinking in pictures with decreased functional connectivity. *Brain, 129,* 2484-2493.

Karmiloff-Smith, A. (1998). Development itself is the key to understanding developmental disorders. *Trends in Cognitive Sciences, 2,* 389-398.

Koirala, S., Parmaksiz, D., Yuan, S. Y., Shultz, S., Klin, A., Jones, W., & Edwards, L. A. (2020). Visual attention in the first two years of life differentially predicts language abilities in children with and without autism spectrum disorder. *Journal of Vision, 20(11),* 1625-1625.

Kolb, B., & Wishaw, I.Q. (1998). Brain plasticity and behavior. *Annual Review of Psychology, 49,* 42-64.

Koshino, H., Carpenter, P. A., Minshew, N. J., Cherkassky, V. L., Keller, T. A., and Just, M. A. (2005). Functional connectivity in an fMRI working memory task in high-functioning autism. *NeuroImage*, *24*, 810-821.

Kuhl, P.K. (2010). Brain mechanisms in early language acquisition. *Neuron, 67,* 713-727.

Kuhl, P.K., Coffey-Corina, S., Padden, D., & Dawson, G. (2005). Links between social and linguistic processing of speech in preschool children with autism: Behavioral and electro-physiological evidence. *Developmental Science, 8,* 1-12.

Lai, B., Yi, A., Zhang, F., Wang, S., Xin, J., Li, S., & Yu, L. (2024). Atypical brain lateralization for speech processing at the sublexical level in autistic children revealed by fNIRS. *Scientific Reports, 14(1),* 2776.

Lasky, E. Z. (1991). Comprehending and processing information in clinic and classroom. In C. S. Simon (Ed.), *Communication skills and classroom success: Assessment and therapy methodologies for language and learning disabled students* (pp. 282-297). Eau Claire, WI: Thinking Publications.

Light, J., McNaughton, D., & Caron, J. (2019). New and emerging AAC technology supports for children with complex communication needs and their communication partners: State of the science and future research directions. *Augmentative and Alternative Communication, 35(1),* 26-41.

Logan, K., Iacono, T., & Trembath, D. (2022). A systematic search and appraisal of intervention characteristics used to develop varied communication functions in children with autism who use aided AAC. *Research in Autism Spectrum Disorders*, *90*, 101896.

Minshew, N. J., Goldstein, G., & Siegel, D. (1997). Neuropsychologic functioning in autism: profile of a complex information processing disorder. *Journal of the International Neuropsychological Society, 3,* 303-316.

Minshew, N.J., & Williams, D.L. (2007). The new neurobiology of autism: Cortex, connectivity, and neuronal organization. *Archives of Neurology, 64(7),* 945-950.

Minshew, N.J., Williams, D.L., & McFadden, K. (2008). Information processing, neural connectivity and neuronal organization. In A. Zimmerman (Ed.) *Autism: Current theories and evidence* (pp. 381-405). Totowa, NJ: Humana Press.

Nathan, J., & Nathan, B.R. (2018). *Building reasoning and problem-solving skills in children with autism spectrum disorders: A step by step guide to the Thinking in Speech intervention.* Philadelphia, PA: Jessica Kingsley Publishers.

Nguyen, A. (2006). *Creating an autism friendly environment.* National Autistic Society.

Parish-Morris, J., Hennon, E. A., Hirsh-Pasek, K., Golinkoff, R. M., & Tager Flusberg, H. (2007). Children with autism illuminate the role of social intention in word learning. *Child Development, 78(4),* 1265–1287.

Paivio, A. (1990). *Mental representations: A dual coding approach.* New York: Oxford University Press.

Prizant, B. M. (1982). Gestalt language and gestalt processing in autism. *Topics in Language Disorders, 3(1),* 16–23.

Quiñones-Camacho, L. E., Fishburn, F. A., Belardi, K., Williams, D. L., Huppert, T. J., & Perlman, S. B. (2021). Dysfunction in interpersonal neural synchronization as a mechanism for social impairment in autism spectrum disorder. *Autism Research, 14(8),* 1585-1596.

Romski, M., Sevcik, R. A., Cheslock, M., Barton, A., McCauley, R., & Fey, M. (2006). The system for augmenting language: AAC and emerging language intervention. *Treatment of language disorders in children: Conventional and controversial intervention*, 123-147.

Rothwell, C., Westermann, G., & Hartley, C. (2023). How do autistic and neurotypical children's interests influence their accuracy during novel word learning?. *Journal of Autism and Developmental Disorders,* 1-15.

Schafer, E. C., Mathews, L., Mehta, S., Hill, M., Munoz, A., Bishop, R., & Moloney, M. (2013). Personal FM systems for children with autism spectrum disorders (ASD) and/or attention-deficit hyperactivity disorder (ADHD): An initial investigation. *Journal of Communication Disorders, 46,* 30-52.

Schelinski, S., & von Kriegstein, K. (2023). Responses in left inferior frontal gyrus are altered for speech-in-noise processing, but not for clear speech in autism. *Brain and Behavior, 13(2),* e2848.

Schlosser, R. W., & Wendt, O. (2008). Effects of augmentative and alternative communication intervention on speech production in children with autism: A systematic review. *American Journal of Speech-Language Pathology, 17,* 212-230.

Shultz, S., Klin, A., & Jones, W. (2018). Neonatal transitions in social behavior and their implications for autism. *Trends in Cognitive Sciences, 22(5),* 452-469.

.

Siugzdaite, R., Bathelt, J., Holmes, J., & Astle, D. E. (2020). Transdiagnostic brain mapping in developmental disorders. *Current Biology, 30(7),* 1245-1257

Smith, D., McConnell, J., Walter, T., & Miller, S. (1985). Effect of using an auditory trainer on the attentional, language, and social behaviors of autistic children. *Journal of Autism Developmental Disorders, 15,* 285–302.

Smith, E.E., Jonides, J., Marschuetz, C., & Koeppe, R.A.C. (1998). Components of verbal working memory: Evidence from neuroimaging. *Proceedings of the National Academy of Sciences, 95,* 876-882.

Tek, S., Jaffery, G., Fein, D., & Naigles, L. R. (2008). Do children with autism spectrum disorders show a shape bias in word learning? *Autism Research,1(4),* 208-222.

Trapani, J. A., Bednarz, H. M., & Kana, R. K. (2022). Brain function and brain connectivity in autism. In *The Neuroscience of Autism* (pp. 107-126). Academic Press.

Uddin, L. Q., Supekar, K., & Menon, V. (2013). Reconceptualizing functional brain connectivity in autism from a developmental perspective. *Frontiers in Human Neuroscience*, *7*(458), 1-11.

Walenski, M., Tager-Flusberg, H., & Ullman, M. T. (2006). Language in autism. In S. O. Moldin & J. L. R. Rubenstein (Eds.), *Understanding autism: From basic neuroscience to treatment* (pp. 175-203). Boca Raton, FL: CRC Press, Taylor & Francis Group.

White, S. W., Mazefsky, C. A., Dichter, G. S., Chiu, P. H., Richey, J. A., & Ollendick, T. H. (2014). Social-cognitive, physiological, and neural mechanisms underlying emotion regulation impairments: Understanding anxiety in autism spectrum disorder. *International Journal of Developmental Neuroscience, 39,* 22-36.

Williams, D.L., Cherkassky, V.L., Mason, R.A., Keller, T.A., Minshew, N.J., & Just, M.A. (2013). Brain function differences in language processing in children and adults with autism. *Autism Research, 6,* 288-302.

Williams, D. L., Goldstein, G., & Minshew, N. J. (2006). Neuropsychologic functioning in children with autism: Further evidence for disordered complex information processing. *Child Neuropsychology, 12,* 279-298.

Williams, D.L., Goldstein, G., & Minshew, N.J. (2015). Further understanding of complex information processing in verbal adolescents and adults with ASD. *Autism* (Special issue on adults with ASD), 19, 859-867.

Wolford, G., Miller, M.B., & Gazzaniga, M. (2000). The left hemisphere's role in hypothesis formation. *Journal of Neuroscience, 20,* 1-4.

PCS Information:

Mayer-Johnson, 2100 Wharton Street, Suite 400, Pittsburgh, PA 15203
Phone: 1 (800) 588-4548
Fax: 1 (866) 585-6260
Email: mayer-johnson.usa@dynavoxtech.com
Web site: www.mayer-johnson.com